

Kentucky Geological Survey

CHARLES J. NORWOOD, Director.

REPORT

ON THE

Progress of the Survey

FOR THE YEARS 1906 AND 1907.

By CHARLES J. NORWOOD.

LEXINGTON, KENTUCKY.

THE GLOBE PRINTING COMPANY.
1908.

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LETTER OF SUBMITTAL.

To His Excellency, AUGUSTUS E. WILLSON,

Governor of Kentucky.

Sir: I have the honor to submit the following report on the progress of the Geological Survey for the years 1906 and 1907 for your consideration, and for transmittal to the General Assembly.

Very respectfully,

CHARLES J. NORWOOD,

Director, Kentucky Geological Survey.

LEXINGTON, KY., December 6, 1907.

PERSONNEL OF THE SURVEY.

The following persons are now, or have been, employed on the Survey, named in the order of their appointment under each class:

Director.—Charles J. Norwood.

Assistants in Geology.—Joseph B. Hoeing (also Cartographer), Arthur M. Miller, Aug. F. Foerste, W. F. Pate (1906), Albert R. Crandall, James H. Gardner (resigned August 1, 1906), Samuel A. Denny (parts of 1906 and 1907), F. Julius Fohs, and James M. Hodge. Mr. L. N. Taylor served as field aid for part of 1906.

Chemistry and Technology.—Alfred M. Peter, chief chemist and in charge of soil testing; Franklin E. Tuttle, chemist for part of 1907; Harry D. Easton, assistant in technology of clays, etc.; J. S. McHargue, chemist.

Miscellaneous.—F. Grider McKay, clerk; George F. Brockman, topographic aid in 1906, aid in technology and field aid soil survey in 1907; William W. Shelby, Jr., topographic aid in 1906, head of field party in oil well survey in 1907; Wallace Newberger, compiling revised chemical report and drafting; N. D. Bentley, copyist; Percy S. Wilson, draftsman in 1907 (resigned); Graham Edgar, field aid in soil survey in 1907.

Topographic.—Joseph S. Shaw, assistant (resigned in May, 1906); Henry B. Pope, assistant (resigned in March, 1907); James W. Norton and Sterling B. Price, field aids in 1907.

Other persons were employed occasionally, during the time covered by this report, but only for brief periods.

In the co-operative topographic mapping large field parties, under the direction of topographers of the U. S. Geological Survey, were employed. It is not deemed necessary to give the long list of names here.

REPORT OF PROGRESS.

The law which governs the Survey requires that our mineral resources shall first be studied by subjects, and bulletins thereon be issued as rapidly as they can be prepared, after which shall come detailed reports on the counties; also, that the soils, timbers and water-powers shall be reported upon, and that topographic mapping of the State shall be carried on. To meet this requirement and cover the various mineral deposits known to occur in the State (irrespective of those that may be discovered in the course of exploration), bulletins must be issued on the following subjects: Bituminous coals (domestic; steam, cannel, etc.), clays fit for various purposes, cement materials (natural and Portland), structural and other stones, road materials (including asphalt rock, dike rocks, Devonian black shale, gravel beds, limestones, etc.), lead, zinc and iron ores, polishing materials, petroleum, and natural gas (and materials from which fuel gas can be cheaply made), potash shales and earths, phosphatic limestones and shales, mineral waters (including those carrying domestic salt, Crab Orchard salts, bromine and lithia), pure water and water horizons, fluorspar, heavy spar (barite) and calcspar, pigment earths and ores, sands (for moulding, plaster, glass, brick, etc.), timbers, water-powers, etc. The Survey is striving to comply with the requirements in the fullest way possible under the limitations which at present control its plans; seventeen bulletins have been completed, five are nearly ready for the printer, and material for others has in part been collected. Expedition has been urged upon all members of the Survey, and they have responded in a manner that is most gratifying.

It is believed that the work accomplished by the Survey since its re-establishment in 1904 will well bear comparison, both as to quantity and quality, with that of other Surveys, and had the printing of completed reports kept pace with their preparation a larger number of bulletins would be

ready for distribution than may now be named. It must be admitted, however, that as a result of the driving necessity for quick reports, it has not been possible in some instances to give that degree of finality to bulletins that, for a thorough statement of our resources, must eventually be reached. So long as the plans of the Survey must be confined within the limits of biennial appropriations, this difficulty will continue. The maintenance of the Survey until full and thorough reports shall have been made on all our mineral deposits and on all the counties is a business necessity, and better results will be obtained with a continuous annual appropriation, even though of smaller amount, than if plans must be cut to suit the limits of uncertain biennial appropriations. It is therefore recommended that a continuous annual appropriation be made for the Survey.

The work of the Survey comes under four heads, namely, geological, topographical agricultural (or soil survey), and chemical and technological. Following is a report of the subjects covered during the past two years:

THE COAL FIELDS.

At no time has greater interest been manifested in our coalfields than now, and it is of a less speculative nature than hitherto. A large amount of capital is being placed in both fields for development purposes, and more is seeking investment. The recent decision of our Court of Appeals, giving stability to land titles in the Eastern Field, will doubtless make for the development of large areas of that field that otherwise would have lain idle. A marked feature of the correspondence of the Survey is the interest manifested in our coalfields, Western as well as Eastern, by Pennsylvania and West Virginia capital. The rising value of coal territory is illustrated by a statement which recently appeared in one of the trade journals. It is stated that in 1896 coal lands in the very best of the Pittsburg seam, at all distant from railroads, could hardly be sold for six to ten dollars per acre, whereas they are now eagerly sought at greatly increased figures; that in 1899 lands near rail and water sold for \$30.00 and \$100.00 per acre, as the "top notch," whereas in 1901 and 1902

options were taken at \$90.00 and \$130.00 an acre. Moreover, that prices have gone as high as \$600 and \$700 an acre where \$100 would have been high in 1901, and \$150 high even in 1905.

Coals of the Licking Valley.—Prof. A. R. Crandall, for a short time assisted by Mr. Denny, has completed the field work and report on this region, which covers an area of about 900 square miles. Necessarily the report covers some contiguous territory, and therefore includes Morgan, Magoffin, and parts of Breathitt, Wolfe, Menefee and Elliott counties. The report shows a finer field of bituminous coal, in addition to the cannels, in the district covered than has hitherto been known.

The Pineville, Log Mountain, Barbourville District.—The field work in this district, which lies in Bell and Knox counties, was completed in 1907, and the report is ready for the printer. This is the joint work of Mr. G. M. Sullivan and Prof. Crandall, Mr. Sullivan having covered a considerable part of the ground in previous years. An area of about 200 square miles is included. Correlations of certain coals that appear on both sides of Pine Mountain were made, thus materially simplifying the work of the engineer engaged in opening up the coals of the district.

Upper Cumberland River District.—Mr. James M. Hodge, assisted for a time by Mr. J. H. Gardner, has completed field work on the Poor and Clover Forks of the Cumberland river, in Harlan and Letcher counties, covering practically the whole of the Big and Little Black Mountains in Kentucky and embracing an area of about 350 square miles. The report is nearly ready for the printer, but it is doubtful whether it can be completed before the Spring of 1908, since the large amount of detail renders its preparation slow and laborious. The work in this almost unknown but great region was thoroughly done, and the report should prove very helpful in forwarding the development of that part of the State. The total number of workable beds determined is about twelve, including an exceptionally fine coal, five to six feet in thickness, with little or no parting, hitherto but little known. The total number of coal seams of all thicknesses found in the field is about forty. With the completion of Mr. Hodge's work cov-

ering the upper twenty-five miles of the valley, together with the work of Dr. Ashley and Dr. Glenn in the stretch from Harlan C. H. to Middlesboro, done in 1902, and the work of Mr. Sullivan and Mr. Crandall in the Log Mountain area, the whole of the Cumberland river region south of Pine Mountain has now been covered, and the value of one of the greatest of our coal regions will become fully known.

The Three Forks of the Kentucky River.—The coals of the region drained by the Three Forks of the Kentucky river have been studied by Mr. Hodge, and his report is ready for the printer. Much was found to add to the preliminary report made by Mr. Hodge some years ago. A brief summary of the report, prepared by Mr. Hodge, is given in the Appendix to this report. Much interest has been manifested in the coal values of the region, and this summary should prove helpful in determining the question of developing the territory in question. The report embraces an area of about 1,400 square miles.

Coals of the Lower (Conglomerate) Measures on the Western Border of the Eastern Coalfield.—The study of this important and hitherto little understood strip was placed in the hands of Prof. A. M. Miller in the spring of 1906. Field work was completed in 1907. The report is ready for the printer, and two of the three large maps are ready for the engraver. The area covered embraces about 1,800 square miles. It embraces all the territory between the Cincinnati Southern and Louisville & Nashville railroads, with additional ground on either side, and includes more or less of Pulaski, Whitley, Laurel, Rockcastle, Jackson, Owsley, Lee, Menefee, Wolfe, Powell and Estill counties. One of the most important features of the report is the correlation of the several coals that occur within its limits. A summary, prepared by Prof. Miller, is given in the Appendix to this report.

Coals of the Western Coalfield.—This work is in the hands of the Director, who has been assisted by Mr. S. A. Denny and, recently, by Mr. Fohs. It was expected that the work would be completed and the report made ready for the printer ere now, but the sudden and serious illness of Mr. Denny, which finally removed him permanently from the field,

has caused delay. Work has been carried on in Muhlenberg, Ohio, Hopkins, Henderson, Union, Daviess, McLean and Webster counties. One of the gratifying results of the past season's work is the definite determination of the extension of the "Henderson" coal over the larger part of Henderson county and into Daviess and Webster counties—as far west as Corydon, as far south as Sebree, and as far east as Birk City in Daviess county, possibly even farther east. Since this area is flat, with but few outcrops, it has been little understood hitherto. It is believed that the 5-foot coal now worked in the Keystone shaft at Henderson, which occurs about 283 feet below the "Henderson," is co-extensive with the "Henderson" bed. It has also been definitely determined that there are several workable coals above what is known in the Western Field as No. 12, and which has hitherto been regarded as the highest workable bed in the field.

THE ROUGH CREEK ANTICLINE.

It seems well to repeat the brief remarks made about this uplift in my report for 1904-'05. The anticline is part of a very important disturbance which apparently extends quite across the State, in an approximately east and west direction, from Shawneetown, Ill., to near Warfield, Martin county. It is important to know what relation it bears to the coals of the Western Field, especially in Ohio, McLean, Webster and Union counties, and its study is of value in prospecting for oil and gas. Prof. W. F. Pate began work on the disturbance in 1905, and it was hoped that he could continue the work in 1906 and complete it during 1907, but circumstances, complicated by a misunderstanding, intervened. It is hoped that the work may be resumed by Prof. Pate during the coming year and be carried to completion.

OIL AND GAS.

One of the most useful of the bulletins that has been issued by the Survey is the report on the Gas and Oil Sands of the State by Mr. J. B. Hoeing. Had such a report been available some years earlier, it would have pointed the way to more intel-

ligent drilling and would have rendered unnecessary much of the "wild catting" that has been carried on. It would be well, indeed, for those who are disposed to drill for oil in the north-central part of the State to consult this bulletin before undertaking experiments in a large way. The report shows that there are reasonably fair chances of obtaining good supplies of natural gas by deep drilling in that area, but that despite startling accounts of "50-barrel" wells in the "bluegrass region" and the actual finding of small quantities of oil here and there, the probabilities of obtaining petroleum in commercial quantities are small. In the production of crude petroleum, Kentucky, bracketed with Tennessee (which produces but a small proportion of the joint output), ranks about ninth among the eighteen oil producing States. It is believed that naturally it could rank higher. It has been asserted by Mr. W. T. Griswold, in a report on petroleum for the statistical division of the U. S. Geological Survey, that "the most probable area from which an increased production of the Appalachian field may be obtained" is presented by Kentucky and Tennessee. It was expected that Mr. Hoeing would extend his field studies systematically westward, but the demands upon his time in the preparation of various maps, including the new geological map of the State, have prevented his doing so. The work of collecting data has been kept up by Mr. Hoeing as well as possible by correspondence, by the collection of records of new wells drilled, by occasional trips into the field, and by a number of special trips made for the purpose of giving aid in the field to oil operators. Many of the latter trips have been without expense to the State, but in all such cases the State has had the benefit of the notes and data secured. Records of drilled wells in addition to those already published have been secured from the counties of Allen, Barren, Bath, Bell, Christian, Cumberland, Fayette, Hopkins, Knox, Lee, Logan, Menefee, Morgan, Wayne, and Wolfe, and from some of the counties along the Ohio river in Indiana which give sections available for the Kentucky side as well. Field trips have been made in Barren, Breathitt, Bath, Fayette, Lee, Logan, Morgan, Wolfe and Knox counties. Field work for the underground survey of

the State was started in the season of 1907 and carried throughout the summer by Mr. W. W. Shelby and party under Mr. Hoeing's direction. The work consisted of level and transit lines connecting various wells and prominent surface points to enable them to be plotted and connected with sea level, and thus render possible the plotting of the different formations as found underground. The work began at Bowling Green, Warren county, was carried into Allen, Simpson and Barren counties, and ended for the season at Burksville, in Cumberland county.

During 1907 much interest was aroused by the finding of gas in shallow wells that had been bored for water on the farm of Mr. C. E. Downing, in Fayette county, and on that of Mr. Hardin Fields, in Woodford county. In view of the various publications concerning the discoveries, it was deemed well to issue an official note concerning them, which is here reproduced: "Since the discovery made by the State Geological Survey that natural gas occurs in commercial quantity in the Kentucky 'Calcareous' beds (the deepest rocks that have yet been penetrated in the State, and which nowhere come to the surface), it has encouraged deep boring for fuel gas in Central Kentucky wherever the structure seemed favorable. In addition, it has kept diligent watch for finds in the shallower rocks, in order that by systematic study of them a satisfactory 'working hypothesis' may be arrived at upon which prospecting may be carried on in an intelligent way. As a rule, the finds of gas in the shallower rocks in the central part of the State, though of rather frequent occurrence, are feeble flows from quickly exhausted pockets, which, though they might for some time supply sufficient gas for one or two households, have no general commercial importance. One should, therefore, be very conservative when forming an opinion as to the supplies of gas that may be derived from the shallower beds in the Blue Grass region. The Downing strike in Fayette is out of the ordinary; that on the farm of Mr. Fields, in Woodford, is doubtless representative of many others that have been made in the past, but which escaped general notice. Both have been examined by Mr. J. B. Hoeing, assistant geologist on the Survey, who still has them under observation. The

following brief statement concerning them has been prepared by Mr. Hoeing:

“*The Downing Well.*—This gas well is on the farm of Mr. C. E. Downing, three miles south of Lexington, on the Nicholasville pike. The well was being drilled for a water supply, but without avail; gas, instead, was struck at a depth of 205 feet, and the well was drilled to a total depth of 220 feet. The well was started at about 20 feet above the base of the Winchester formation (the Lower Hudson of the old reports), and passes nearly through the Lexington (better known as Trenton), stopping in the Lexington a short distance above the Logan division, and probably about 60 feet above the Tyrone or Birdseye. No water at all was struck in the well, the gas being perfectly dry. The history of the numerous shallow wells in the blue grass region of Central Kentucky has shown them often to be shortlived and pockety. This well, so far, has proved to be an exception to the rule. It was allowed to blow off in the air for five days, showing in that time only a small diminution in volume and pressure. The rock pressure is higher than would be expected for the depth of the well, but was not measured. The volume, after flowing open for five days, was measured by the writer and gave 56,000 cubic feet in 24 hours. The well was then closed up and rested for three days and then opened and left open long enough to bring it down to the open pressure and measured, when the average of five careful measurements gave a volume of 65,000 cubic feet in 24 hours, with apparently no diminution in pressure. This, so far, is a remarkably good well for this section, and if it holds up to anything near its present production will prove quite profitable to the owner as a source of heat, power and light sufficient for the immediate neighborhood. It is to be regretted that so much of the gas was allowed to waste in the air; probably more than a year's supply for the owner's house went into the air during the time it was open. The well has been closed in and the owner will pipe the gas to his house and barn and use it for heat, and probably also attach coils to the main pipe for refrigerator.

“*The Fields Well.*—This well is on the farm of Mr. Hardin Fields one mile east of Versailles, in Woodford county.

The well was drilled for water. It starts just below the top of the Lexington and is entirely in the upper part of that formation, being only 40 feet deep. Gas was struck at 16 feet, and apparently more a little deeper. A strong vein of water came in below the gas and stands 25 feet deep in the well. The well was fastened up in such way that at the time of the writer's visit the volume could not be measured. It is a small gas well, but there is enough gas there now to supply Mr. Fields' dwelling with light and heat. It is problematical as to whether this gas will last, but if it does hold out and the water does not drown it, the well will be used for a home supply of light and heat and possibly occasional power on the farm. ”

LEAD, ZINC, AND SPAR DEPOSITS.

Western Kentucky.—The field work for the general study of the lead, zinc, fluorspar and barite deposits of Western Kentucky was completed by Mr. Fohs and the report is ready for the printer. The report covers the counties of Caldwell, Crittenden, and Livingston, and parts of Christian, Lyon and Trigg, is in great detail, illustrated with many figures and plates, and accompanied by three large maps. In a brief summary referring to the deposits of the six counties, Mr. Fohs says:

“The conclusions reached concerning these deposits are, briefly: The fluorspar supply is practically inexhaustible; zinc ore occurs in more considerable quantity than previously supposed, and the assured solution of the milling problem should greatly increase its production; lead occurs in sufficient quantity with both the fluorspar and the zinc deposits to make a nice profit above what is secured from either type of deposit alone; large pure calcspar deposits occur which will repay mining; favorable conditions occur in parts of northern Christian, northern Lyon, northern Trigg and eastern Crittenden counties, thus extending the eastern, southeastern and southern limits of the district; chances for economic deposits appear less in the faults near the borders than those near center of field; chances along undeveloped portions of the main faults and their complementary fractures, especially in the limestone but also in the quartzite walls, are good and more

cross-cutting is advisable. One of the results of the work was the discovery of a simple method of determining the probable strikes of cross and intersecting complementary fractures, where the strike of one fault is known. Recent development work showed highly favorable results, many good ore shoots being found on old properties, both along the strike and in depth, along the faults."

A special report on the Kentucky Fluorspar Deposits has also been prepared by Mr. Fohs. This report describes the general occurrences of fluorspar in the State, its statistics up to 1907, the methods of mining, the technology of the mineral, etc. The report is in type and should soon come from the press.

Central Kentucky.—It was expected that the study of the vein deposits of the central part of the State would be completed by the end of 1907, but it could not be done, other work interfering. That the mining of barite, with lead and zinc as byproducts, will become quite an important industry in Central Kentucky seems beyond question. We may also expect the mining of fluorspar to assume importance whenever a cheap and ready means for separating barite and calcite from it may be found—a problem which the Survey now has in hand. The barite occurs in veins of considerable depth and linear extent, and not in "pockets" as has recently been stated by a writer in the public press. There is an abundance of the mineral in the counties forming central Kentucky—enough to last for very many years at the present rate of production in this country. It is believed that this region offers advantages over Virginia, where, according to the *Engineering and Mining Journal* "it is rather hard to accumulate sufficient barytes to run a good sized mill;" and it is significant that Virginia capital has come to this district and has erected a mill for handling the mineral. (The Jessamine Barytes Company, at Nicholasville). The Survey has succeeded in drawing attention to the district and many leases for mining barite have been effected. A general statement concerning the deposits was given in my report for 1904-'05, and other data will be found in the bulletin on fluorspar, now in type.

SOIL SURVEY.

What may be regarded as in some respects the most important work undertaken during 1907 is the soil survey. Preparatory work for this, in the way of classifying and mapping the rock formations, began in 1905. The object of the survey is to systematically sample and study the soils over the State so that a map may be prepared which will show the character of soil in the various regions. For the construction of such a map, the geology must be worked out first, so that the divisions of the different formations may be laid down; then a systematic course of sampling of the soils made by the various rock beds is carried on, and the samples are analyzed or otherwise treated with a view to determining for what plants the soils are best suited, or what the soils may need in the way of fertilizers to grow good crops of various sorts of plants. This work is being carried on in cooperation with the Director of the State Agricultural Station, the Survey doing the geology, collecting the samples, and doing the mapping, while the Station investigates the character and needs of the soils. The Station work is in the hands of Dr. A. M. Peter. The field work during 1907 was in the hands of Prof. Aug. F. Foerste, assisted by Mr. George F. Brockman and Mr. Graham Edgar. Too much can not be said in commendation of the work of these gentlemen. Nearly 700 samples were collected, chiefly from the Subcarboniferous (Mississippian) area, shown in two shades of blue on the State geological map, in the counties of Meade, Breckenridge, Grayson, Edmonson, Larue, Warren, Hart, Simpson, Logan, Todd, Christian, Trigg, Livingston, Lyon, Caldwell, Crittenden, Barren, Allen, Metcalfe, Adair, Green and Taylor, and from the more recent formations in Graves. Each other formation is to be similarly sampled as the work goes on, and all the counties covered. The methods of the field work, other than determinations of geology, with sundry comments, are described by Prof. Foerste in a summary which is given in the Appendix.

As part of the cooperative work with the Agricultural Experiment Station, it is proposed to carry out this winter and next spring a number of pot experiments with the soils collected by the Survey. These experiments will be conducted

by Dr. Peter. The first object of this investigation is to study and compare the manurial requirements of the principal types of agricultural land existing in the State. To this end, suitable plants, such as wheat, oats, peas or clover, will be grown in pots of the soil to be tested, both without any addition and with the addition of the important constituents of fertilizers, separately and in various combinations. For example: A series of eight pots might be arranged, No. 1 without addition; No. 2 with phosphate; No. 3 with potash salt; No. 4 with nitrate of soda; No. 5, phosphate and potash salt; No. 6, phosphate and nitrate of soda; No. 7 potash salt and nitrate of soda; and No. 8, phosphate, potash salt and nitrate. By comparing the growth of wheat in such a series of pots, it will usually be apparent which of the substances tried, taken singly, or which combination, has produced the best growth, and a general inference can be drawn as to whether the soil tested needs phosphorus, potassium, or nitrogen, to produce a good crop. Knowledge of this kind will be of practical value to the farmers of the State, as a guide in the selection of the right kind of fertilizers. This is a practical question that is presenting itself more and more forcibly to our farmers as the difficulty of producing good crops without fertilizers becomes greater.

There are other problems which it is desirable to study in these experiments. For a number of years, chemists have been endeavoring to determine the needs of soils by chemical analysis. The quantity of plant food which can be extracted from the soil by means of a weak solvent is taken as an indication of the quantity that is available to plants. The Experiment Station has been following a method of this kind for many years with a fair degree of success in predicting what kind of fertilizers can be used to advantage, but it is believed that by comparing the results of the pot experiments with the chemical analyses of the same soils, relations may be discovered which will make the results of chemical analyses of more practical value than at present, by enabling the chemist to more accurately interpret their meaning.

The Bureau of Soils of the U. S. Department of Agriculture studies, classifies and maps soils with reference to their physical characters. The Bureau makes what is called a

mechanical analysis, which shows the proportions of clay and sand of various sizes. This gives an idea of the way the soils will behave toward tillage, and a general of the crops for which the soil is suitable. The Bureau does not make chemical analyses of soils, but advocates the making of a special form of pot experiments, conducted in small wire baskets, for testing the manurial requirements. It does not undertake this work extensively, but expects it to be done by the farmers themselves or by others more directly interested than is the Bureau. Consequently, the surveys made by the Bureau, of which we have had several in the State, covering the counties of Union, Warren, Madison, Mason, McCracken and Scott, show the areas covered by the soils of the several types recognized by the Bureau, but they do not indicate whether or not the farmer can use commercial fertilizers with advantage. The work of the State Survey and the Experiment Station will aid in supplying this information.

CHEMICAL AND TECHNOLOGICAL WORK.

Many analyses have been made of coals, ores, clay, stones, waters, etc., but hitherto the volume of chemical work has been much less than was desired, and the amount of technological testing has been small. This has been due not only to the fact that field work has called for so large a proportion of our funds, but to the circumstance that hitherto the Survey has lacked laboratory rooms and appliances of its own. Having no laboratory, it was not possible to employ a chemist who could give his entire time to work for the Survey, hence unavoidable delays in obtaining results have occurred not only with respect to analyses needed by the Survey but also with respect to those asked by citizens throughout the State. Within the last six months, however, the Board of Trustees of State College has provided a mining laboratory building, in which space has been set aside for the Survey; nearly all the necessary chemical and technological equipment has therefore been procured, and a chemist who will give his entire time to the Survey has been employed. The Department of Mining Engineering of State College will cooperate with the Survey in technological work, which will prove mutually helpful.

The determination of the heating values of our coals has been begun, numerous samples having been tested during the present year. The importance of this line of investigation will be recognized by those engaged in the coal trade, since the tendency now is to purchase coal for large consumers according to the heat units it yields rather than according to the flat price at which it can be bought. It is planned to also test our coals for weathering qualities and for storage under various conditions.

As stated in the report for 1904-'05, Kentucky is beyond question a great clay State, but it is difficult to interest ceramic industries in strange clays unless the latter have been subjected to various technical tests and the results have proven satisfactory; few established industries are willing to make the tests themselves, hence the Survey has hitherto been at a disadvantage in its efforts to attract the attention of clay workers. We are now, however, prepared to undertake the work and kiln tests will be made of our clays for bricks, pottery, tiles, etc. For this purpose a large Caulkins pottery kiln and a Braun combination kiln have been purchased.

Among the other sorts of technological work planned are: The examination of the explosive qualities of the dust of our various coals; the study of clays for cement, including the availability of the gypseous clays of the Purchase for Keene's cement or for Portland; testing of stone, including crushing strength, weathering, etc.; determination of the crushing strength of our coals, for the benefit of mining operations, in order that intelligent estimates may be made as to the sizes of pillars required for safety; washing and blending coals for coking, a line of investigation that should, if satisfactory results are obtained, prove quite useful in several parts of the Eastern field; the critical examination of Kentucky galenas (lead) for silver, and of manganiferous deposits for cobalt and nickel; separation tests of our zinc and lead ores, of mixtures of fluorspar and calcite, and of fluorspar, calcite and barite; coking tests; and testing of road materials. A thorough testing of our road materials, asphalt, limestone, gravel, clay and Devonian black shales, is a matter of immed-

iate importance. I believe the use of burnt clay may prove the solution of the good roads question of our mountain counties and of other counties where other material may not be readily obtained. The shale beds so abundant in the mountain counties need to be tested as to vitrifying qualities, and as to the best temperature for burning various sorts, the simplest manner that will suffice, and the effect of various percentages of sand, etc. Limestone should be tested for strength, toughness, binding qualities, etc; and the effect of mixing various percentages of petroleum and sand (in a simple way) should be determined for the various sorts.

MISCELLANEOUS MAPS.

During the period covered by this report the following maps have been prepared by Mr. Hoeing: (1) A new geological map of the State, on a scale of 10 miles to the inch, the formations being shown by standard colors. The several geologists of the Survey, including Mr. Hoeing and the writer, have cooperated in outlining the formations shown on the map. On this map the outlines of the coalfields, the more recent formations, the Devonian, the Silurian, and the large divisions of the Ordovician or Lower Silurian (i. e., the Cincinnati and Mohawkian, the latter including Trenton in its upper part) are outlined with a close approach to accuracy; the lower large division of the Mississippian (Subcarboniferous), i. e., the Keokuk-Waverly, indicated by the deeper shade of blue, however, is not so well outlined, though it is shown more accurately than on preceding maps. It is now known—too late to make the corrections on the map—that in some parts, as in sections of Metcalfe, Green and Taylor counties, the Keokuk-Waverly occupies areas shown on the map as upper Mississippian (light blue); it is also known that there are areas of the Devonian black shale (Ohio black shale of Kentucky reports, "Chattanooga shale" of U. S. Survey reports) at the surface in Adair, and perhaps in adjoining counties, where Keokuk-Waverly is shown. Our lack of accurate knowledge of the outlines of the Keokuk-Waverly was fully appreciated during the preparation of the map, but it was deemed well, in view of the wide and persistent demand for a geo-

logical map of the State, not to defer the preparation of this revised edition until all the details of the Subcarboniferous could be determined. This map has been printed. (2) Map of the upper Cumberland region, to accompany report of Mr. Hodge, showing parts of Harlan, Leslie and Letcher counties, and adjacent territory of Virginia. (3) Map of the Big Sandy Valley region, to accompany the report of Mr. Crandall, including Pike, Johnson, Floyd, Lawrence and Martin counties, and adjacent territory in West Virginia. This has been printed. (4) Map of the Pineville, Log Mountain and Barbourville region, including parts of Knox, Whitley and Bell counties, to accompany report of Mr. Crandall and Mr. Sullivan. (5) Map of the Upper Licking drainage, including Morgan, Magoffin, and Elliott counties, and parts of Carter, Lawrence, Johnson, Breathitt, Wolfe, Menifee and Rowan, to accompany report of Mr. Crandall on the coals of the region. (6) Two maps covering the Conglomerate outcrop on the western border of the Eastern Coalfield, including, in part or in whole, Wayne, Pulaski, Whitley, Laurel, Rockcastle, Jackson, Owsley, Lee, Madison and Estill counties, to accompany report of Mr. Miller. (7) Map including Trigg and Christian counties, to accompany the report of Mr. Fohs. (8) In addition to the larger maps, nearly 500 illustrations (sections, page maps, etc.,) for the various reports that have been prepared. Mr. Hoeing is now preparing an additional map for the report of Mr. Fohs and an additional one for the report of Mr. Miller.

CO-OPERATIVE MAPPING.

The topographic work has been carried on in co-operation with the U. S. Geological Survey, each Survey paying one-half the salaries and field expenses but the expense of publication being borne by the Federal Survey. During the last two years, 2,134 square miles of the area of the State have been completely mapped, making 3,198 square miles completed within four years. In addition, a large amount of primary traverse, for the control of additional areas, has been completed, and in 1906, 126 miles of precise leveling were run. Bad weather seriously interfered with field work in 1906, but

the present year has been especially fruitful of results; during this year 1,345 square miles have been completely mapped, and primary traverse is in progress over the Princeton, St. Charles, Nortonville and Greenville quadrangles, in Caldwell, Hopkins, Christian, Muhlenberg, Todd and Logan counties.

Now seems an opportune time to make a plain statement about the topographic mapping done in the Eastern Coalfield some years ago. Map diagrams which have been issued indicate that the mapping of that field has been completed, but it may as well be stated now that most of the quadrangles that were covered prior to 1900 were very imperfectly mapped, that the published sheets contain many errors, and that revisions must be made. In the beginning of the co-operative topographic work (1904), the published maps were accepted as, in the main, final; but more critical examinations and subsequent experience in the field have disclosed the superficial character of the work, and that the maps with a few exceptions can be considered as no more than reconnaissance sheets, a fact which the U. S. Survey recognizes by now labeling them as such. It is due the present Geographer in charge and due his immediate predecessor to say that the maps were issued prior to their "time," and it is also due the field men of their predecessors to say that more was demanded of them within a limited time than it was possible for them to accomplish accurately. Moreover, it must be distinctly recognized that, though marred by errors, these reconnaissance maps of the Eastern Field have been of exceeding value in the development of that territory; before they were issued there were practically no maps at all of the region.

Nearly three-fourths of the Western Coalfield has been mapped within the last four years; indeed, approximately five-sixths of the total area of good coals has been covered.

Of Rowan and Lewis counties we have less in the way of maps than of any other counties in the State; for some reason they have in the past received little attention. It is planned, with the continuation of the Survey, to have them mapped as speedily as possible, and also to have revisions made of several quadrangles in the Eastern Field.

Necessary primary triangulation has been extended over Breathitt, Floyd, Knott, Letcher, Leslie, Perry, and Pike counties, for control of the Regina, Hazard and Whitesburg quadrangles and eight monuments were set and their positions accurately determined.

Precise Levels were extended through Bourbon, Breathitt, Clark, Fayette, Lee, Powell and Wolfe counties, for control of levels in the Paris, Austerlitz, Winchester, Beattyville, Stanton, and Frenchburg quadrangles.

According to counties, the results of the topographic work of the last four years are as follows:

Anderson, primary control of one-half or two-thirds.
 Bullitt, a small part completed and control obtained of more.
 Bullitt, a small part completed and control obtained of more.
 Caldwell, a small part completed; primary control of the larger part.
 Christian, primary traverse of about one-fourth or less.
 Crittenden, about one-fourth completed.
 Daviess, completed.
 Fayette, nearly two-thirds done.
 Floyd, primary control of about one-third for revision.
 Franklin, about one-half completed, and sufficient control to finish the county.
 Grant, control of a small part.
 Hancock, a small part completed in addition to that completed hitherto.
 Harrison, control of a small part.
 Henry, a small part completed.
 Henderson, nearly all done.
 Hopkins, about three-fourths done and primary traverse of nearly all the remainder.
 Jefferson, about three-fourths done, and enough control to complete.
 Knott, between two-thirds and three-fourths controlled for revision.
 Leslie, a part controlled for revision.
 Letcher, a part controlled for revision.
 Logan, a small part covered by primary traverse.
 Lyon, a small part covered by primary traverse.
 McLean, all done.
 Muhlenberg, about four-ninths done and primary control of the remainder.
 Nelson, some preliminary work.
 Ohio, somewhat more than seven-eighths done.
 Oldham, a small part completed.
 Owen, not quite one-fourth done; control of about one-fourth more.
 Perry, primary control of nearly half for revision.
 Pike, primary control of the larger part for revision.

Pulaski, control of part.
 Russell, control of part.
 Scott, a part done.
 Shelby, a small fraction done; control of nearly enough to complete.
 Spencer, control of nearly two-thirds.
 Todd, primary traverse of about one-eighth.
 Union, nearly all done.
 Washington, some preliminary work.
 Wayne, about one-eighth done, control of about one-third of remainder.
 Webster, completed.
 Woodford, nearly two-thirds done; sufficient control to complete.

WORK IN PROGRESS OR PROJECTED.

Following is a brief statement of the work in progress and of some of that projected:

1. General account of Kentucky; begun.
2. Study of the salt waters of the State.
3. Examination of spring waters along the Devonian and Silurian outcrops. It is believed that this investigation will develop as a fact that quite pure waters (useful in treating disorders of the stomach) occur along this outcrop, as has been suggested to the writer by Col. J. Stoddard Johnson. The work has been commenced.
4. Examination of certain spring waters (about 20) for rare elements.
5. Location and examination of sands and sandstones fit for moulding and glass.
6. Study of the paint materials of the State.
7. Study of clay deposits continued, including technologic tests.
8. Study of the asphalt deposits: complete it.
9. Study of iron ores; complete it.
10. Continuation of the soil survey, including field work and chemical and pot tests.
11. Revised report on Whitley county.
12. Study of stones resumed, including sandstones for structural purposes, glass making, etc., and limestones for structural purposes, road making, and cement, and for flux, furnace linings, etc.

13. Study of Central Kentucky mineral veins; complete it.
14. Map the disturbances of the State, with reference to oil and gas horizons, and the affect on the amount of available coal; begun.
15. Study of oil and gas horizons continued, especially in the west.
16. Study of the faults in the Western Field, and their effect on the amount of available coal.
17. Study of road materials, including technologic tests.
18. Study of cement and lime materials, continued.
19. Determination of water horizons.
20. Search for peat. Special examination of lignitic deposits with reference to their extent and possible value.
21. Re-examination of the Elliott county dikes.
22. Discrimination of the several divisions of the Sub-carboniferous rocks and the economic values peculiar to each.
23. Continue study of the coal deposits.
24. Continue cooperative topographic mapping.
25. Prepare map showing mineral products according to counties.
26. Begin county surveys.
27. Carry on technologic and chemical work as already outlined.

LIST OF REPORTS.

Printed, Ready for Printing, or in Preparation

1. Oil and Gas Horizons. J. B. Hoeing. Printed.
2. Lead and Zinc Bearing Rocks of Central Kentucky. A. M. Miller. Printed.
3. Chemical Bulletin. Dr. Robert Peter, deceased, compiled by Alfred M. Peter. Printed.
4. Coals of the Big Sandy Valley. A. R. Crandall. Printed.
5. Upper Ordovician Rocks of Kentucky. J. M. Nickles. Printed.
6. Clays in Several Parts of Kentucky. J. H. Gardner and Aug. F. Foerste. Printed.
7. Silurian, Devonian and Irvine Formation of East Central Kentucky and their Economic Contents. Aug. F. Foerste. Printed.
8. Report of Progress for 1904 and 1905, including notes on oil and gas; lead, zinc, fluorspar and barite deposits; clays and coals; rock phosphate, etc. C. J. Norwood. Printed.
9. Livingston County; Its Mineral Veins, etc. Based on the report of R. H. Loughridge, with revisions and additions by F. Julius Fohs. Ready for printer.
10. Fluorspar Deposits of Kentucky. F. Julius Fohs. In type.
11. Mining Thin Coals in Southeastern Kentucky. R. H. Barclay. Ready for Printer.
12. Breckenridge and Meade Counties. R. H. Loughridge and J. B. Hoeing. Ready for printer.
13. Coals of the Licking Valley. A. R. Crandall. Ready for Printer.
14. General Report of the Western Kentucky Lead, Zinc and Spar District. F. Julius Fohs. Ready for printer.
14. Coals of the Region Drained by the Three Forks of the Kentucky River. James M. Hodge. Ready for printer.
15. Coals of the Pineville, Log Mountain, and Barbourville Region. A. R. Crandall and G. M. Sullivan. Ready for printer.
16. Coals, etc., of the Conglomerate Measures on the Western Border of the Eastern Coalfield. A. M. Miller. Ready for printer.
17. The incinnatian Formation and its Economic Values. Aug. F. Foerste. Nearly ready for printer.
18. The Coals of the Poor and Clover Forks of Cumberland River, in Harlan and Letcher Counties. James M. Hodge. Nearly ready for the printer.
19. Key to the State Geological Map. C. J. Norwood. Nearly ready for the printer.

- 20. Coals of the Western Coalfield. C. J. Norwood, aided by S. A. Denney and F. Julius Fohs. Nearly ready for the printer.
 - 21. Asphalt Deposits of Kentucky. C. J. Norwood. Nearly ready for the printer.
 - 22. Iron Ores of Kentucky. C. J. Norwood. Nearly ready for printer.
 - 23. Cement and Lime Making Materials of Kentucky. Begun.
 - 24. Structural and Other Stones of Kentucky. Begun.
 - 25. Coking Coals. C. J. Norwood. Partly done.
- New Geological Map of Kentucky. J. B. Hoeing. Printed.

APPENDIX I.

Abstract of Report on the Lower (or "Conglomerate") Measures Along the Western Border of the Eastern Coalfield.

BY ARTHUR M. MILLER.

Prof. C. J. NORWOOD.

Director, Kentucky State Geological Survey:

Dear Sir: I have the honor to herewith submit a brief abstract of my report on the Lower Measures along the Western Border of the Eastern Coalfield. The field work upon which the report is based was carried on during the summers of 1906 and 1907. Previous to this, extending over a period of fourteen years, excursions had been made from time to time into this territory. I was aided during the summer of 1906 by Mr. L. N. Taylor, of Pulaski county, and most of the references to the coals of that county are based upon his investigations.

Two maps made on the scale of about two miles to the inch have been prepared to accompany the report and are now in the hands of the engraver. A third is in preparation. The two submitted, cover the district from the Tennessee line as far north as 37 degrees and 34 minutes, or about to the southern limits of Madison county. The map in preparation will cover the remainder of the district north as far as 38 degrees, or about to the southern limits of Bath county.

The width of the strip in an east and west direction is determined mainly by the extent of outcrop of the formation known as "The Conglomerate" by some investigators, and as the "Lee," by others. My investigations, however, were not confined exclusively to this formation, but extended in some cases upward into what were once known as the "True Coal Measures," but which in the lower portion are now known as "Breathitt."

The Lee Conglomerate Measures range in thickness from about 900 feet along the western margin near the Tennessee line to about 300 feet at the northern end in Menefee county.

In the southern part of the field, the strata consists of a number of lenses of conglomerate and coarse sandstone interspersed with shales. Prominent among these are the Rockcastle Conglomerate and the Corbin Conglomerate. The former of these is also composed of a number of sub-lenses. North of the Kentucky river the Corbin can not certainly be identified, and the series here falls into two divisions, a conglomerate and a sub-conglomerate member.

In the district somewhat central about Livingston, Rockcastle county, is a conglomerate that cannot be positively identified with the Rockcastle, and is in this report referred to as the "Livingston Conglomerate." It rests down on or close to the Lower Carboniferous Limestone and appears to fill erosion channels in it. The whole conglomerate strip gives rise to very broken country. It is sparsely settled, and roads, other than trails, are few. Where the conglomerate lenses are well developed, the stream gorges are narrow and so filled with boulders that it is scarcely possible to build roads along them. The best roads here are along the crests of the narrow ridges.

The deposits of this region which have economic importance are the coal, the clay, the natural gas, the petroleum and the iron ore. The coal is the most important. In the southern portion there are three seams of coal of sufficient thickness to be workable.

These are in ascending order, the Hudson, the Beaver Creek, and the Barren Fork. I propose for these the numbers One, Two and Three, believing that it is time we should discard the numbering of Owen, which tends to perpetuate the error that the True Coal Measures began at the top of the Conglomerate.*

*The advisability of beginning the numbering of the coals with those that occur in the Lee Conglomerate series is an open question. See foot-note under "Coal No. 1" in Mr. Hodges' summary of the coals of the Three Forks of the Kentucky River, on a succeeding page.—C. J. N.

The No. 1 or Hudson Seam, has its greatest development along the Cumberland river in the vicinity of the mouth of the Rockcastle river, attaining here a maximum thickness of 63 inches of coal separated into two benches by 25 inches of shale. Along the South Fork of the Cumberland, especially in the vicinity of the mouth of the Worley branch, it also attains a considerable thickness, being here 49 to 56 inches thick.

This is the lower of the two coals known more properly as the "Cumberland River Coal" of the early days of Cumberland river coal transportation. In height above the base of the Coal Measures it ranges in the Cumberland river region from 30 to 100 feet.

A tendency to split up into a number of thin seams is a characteristic of this coal, especially in the southern portion of the field. Northward, its distance above the base of the Coal Measures decreases, and a representative of some one of its members is generally found down very close to the Lower Carboniferous Limestone. Sometimes it rests almost directly upon the eroded surface of this limestone.

This is the coal at present mined by the Stearns Company, at the mouth of Worley and Stover branches, on the South Fork of the Cumberland river. It is the lower coal mined at Livingston. It is the coal formerly mined by the Big Hill Coal Co. on the borders of Madison and Jackson counties, and for local use by private parties at numbers of places in Rockcastle and Jackson counties.

It has been opened on Ross creek, just over the line from Estill in Lee county; also on the north side of the Kentucky river on Big Sinking creek. It is worked now in a small way near Dundee, in the Red river drainage, Powell county, and more extensively on Amet's branch of Indian creek in Menefee county. It has also been opened near Scranton, in the Beaver creek drainage, same county. From the former mine, coal is shipped to Mt. Sterling, and from both mines coal is obtained for use on Mountain Narrow Gauge Railroads in the vicinity of which the openings have been made.

In these northern situations the seam, or workable member of the seam, seldom equals or exceeds 24 inches in thickness.

The No. 2, or Beaver Creek Seam.—This also has its greatest development in the Cumberland river region, where it was generally known, in the palmy days of Cumberland river mining and transportation, as the "Main" coal. It ranges in thickness in this region from 40 to 51 inches, and is generally about 150 feet above the base of the Coal Measures. Famous mines upon it in the former days were the "Slipup," Huling, Bear Creek, Doolin, Curd and Doyle; and later, the Beaver Creek.

In the South Fork region it was also formerly much worked, and the mine at Bartell, operated by the Stearns Company at the present time, is in a coal at this horizon. It is here 52 inches thick.

North of the Cumberland river, it has been opened and mined for local use at a number of points in Pulaski county; and at Livingston, in Rockcastle county, it is the coal at present mined commercially by the New Livingston Coal Company. It is also the coal formerly mined at Pine Hill, and by the Big Hill Coal Co. on Brush creek.

It is mined at a number of points in Jackson county, as, for instance, in the vicinity of McKee, the county seat, but only for local use.

It attains a considerable development in the Kentucky river drainage in Lee county, where it is known as the Beattyville Coal.

In the vicinity of the town itself, and extending down the river as far as the mouth of Sturgeon creek and up Duck Fork of that stream to the Forks, many openings have been made on this seam. Throughout the whole area where this Beattyville coal is workable the conglomerate member proper seems to be wanting, or is represented by only moderately coarse and massive sandstones.

The horizon of the coal, however, seems to be below that of the main conglomerate cliff in surrounding regions. It attains in this region to a thickness of 38 to 42 inches, though subject to "rolls" which often cause it to pinch out much thinner.

It has an elevation here above the base of the Measures of

about 140 feet. This is as far north as this coal is known to occur.

The No. 3 or Barren Fork Seam.—This seam is scarcely known to occur north of the Cumberland river. It belongs about 200 feet higher up in the series than No. 2, or about 350 feet above the base of the Measures. It ranges in thickness from 32 to 36 inches. It is the coal mined along the Cincinnati Southern railroad from Cumberland Falls Station to Barren Fork Station.

The Breathitt Formation is characterized by a predominance of shale over massive sandstones and gives rise to a much more level country than does the Lee.

The deposition of these shales was ushered in by an epoch of coal making almost as extensive as that which characterized the beginning of the Coal Measure Time itself.

The No. 4 Seam (the Lily, or Laurel Coal).—This coal, (No. 1 of the older authors), can be traced in almost continuous outcrop practically across the State from Tennessee to Ohio.

It is the coal mined on the Cincinnati Southern railroad just south of Pine Knot, in the vicinity of Strunks Lane, where it is about 28 inches thick and down very close to the top of the Corbin. From here it can be traced, by openings made on it for local use, along the base of "Jellico Mountain," following the sinuosities made by the Marsh and Jellico creeks and their tributaries, reaching in some cases as far as to and beyond the Tennessee line, all the way to Williamsburg on the Cumberland river, where it has been mined 30 inches thick and not over ten feet above the top of the Corbin. The latter has here lost its conglomerate character and is a shaly sandstone.

From here it may be traced up the Clear Fork of the Cumberland to a point about half way between Pleasant View and Saxton.

North of the Cumberland it may be traced in the drainage of Watts creek, close to creek level as far as Rockhold, and has been mined mainly for local use in this stretch.

At Rockhold it passes beneath drainage and nothing more

is seen of it along the line of railroad until the vicinity of Lily, Laurel county is reached. It here rises above drainage again, is 36 to 42 inches thick, and not over 20 feet above the top of the Corbin. The name "Lily" is given it from its typical occurrence in this locality. It is extensively mined here. It again passes below drainage along the line of the railroad and is a short distance below at London, county seat of Laurel county. North of London, it reappears at Pittsburg (36 inches thick and 20 feet above top of Corbin), and may be traced from there in continuous outcrop to East Bernstadt and Altamont, in the vicinity of which two stations it is 37 to 49 inches thick. Here the outcrop line leaves the railroad and may be traced in the drainage of Little and Big Raccoon creeks almost to the Rockcastle river.

The coal is not well developed in Jackson county, but it is seen in the bed of Laurel Fork of Rockcastle river above Moore's Mill, from which it has been raised for local use by stripping.

Passing over into the drainage of Sturgeon creek, some traces of this coal are seen on top of the Conglomerate towards the headwaters of this creek and on some of the tributaries, as, for instance, Travis creek, but it is of no economic importance here.

Lower down on Sturgeon and especially on headwaters of Duck Fork in Owsley county confines of Lee, it begins to assume more importance; but is still mined only for neighborhood use. It still bears its same relation to the top of the Conglomerate. One other opening is seen on this coal—that by the side of the road on the ridge between Pebworth and Beattyville, and then the Kentucky river is reached. The hills in the vicinity of the river are not high enough to catch this coal here, but in the elevated region in the neighborhood of Zachariah P. O., confines of Lee and Wolfe county, there is a coal at this horizon that has been mined for neighborhood use. It is about 36 inches thick here.

Some traces of this coal are seen in that portion of Lee county which lies between the Middle and North Forks of the Kentucky river, but it assumes no importance there. It obtains a greater development in Wolfe county, where in the

drainage of Upper Devil creek it has been rather extensively opened. It is liable here to be badly split up by partings. The coal may average 36 inches in thickness. It is down very close to the Conglomerate.

North of Campton no trace of this coal was found by the writer, though there are extensive ridge areas in northern Wolfe and Menefee counties where the horizon of coal is due.

The No. 5 or Bacon Creek Seam (Lower Blue Gem).—

This seam, named from a tributary of Lynn Camp creek in the vicinity of Corbin, along which it has been rather extensively worked for the Corbin market, is quite persistent in the southern portion of the field. It is never very thick in this region, reaching a maximum of not over 27 inches. In the region south of the Cumberland river it is known as the "Lower Blue Gem." In all this district its position is from 150 to 160 above the Lily Coal, or 170 to 180 feet above the top of the Corbin. Possibly the upper coal, 125 feet above No. 4 in Wolfe county, is this seam. It is here 36 to 40 inches thick and badly split up by partings.

The No. 6 or Upper Blue Gem.—The position of this coal is 225 to 240 feet above the top of the Corbin.

The last two coals are not of any importance south of the Cumberland river except where they can be mined in the same hill along with the next seam above them in the series, namely:

The No. 7 or the Jellico Seam.—This is the main seam throughout a large district in eastern Whitley county.

It belongs to that portion of the Breathitt which tends to become mountainous, so it is usually found a considerable distance above drainage. It ranges in thickness from 30 to 62 inches and is commonly separated into two parts by a parting near the middle.

Its position in the series is from 260 to 300 feet above the top of the Corbin, in all that portion of the area where a steep section from top of the Corbin to the coal could be found.

In the vicinity of Jellico itself, where the Corbin is below drainage, the interval seems to be much greater.

This thickening is in accordance with what we should expect as the Pine Mountain is approached. We know there

is an enormous thickening of all the Measures in the vicinity of this mountain range.

The Jellico Coal has been fully described by Prof. Crandall in his report on Whitley county, published by the Survey during the administration of the late John R. Procter. North of the Cumberland river this seam may be traced in the mountain east of Watts creek and the Louisville & Nashville railroads as far as Rockhold, where its line of outcrop leaves the railroad and trends to the eastward into Clay county.

My investigation did not permit of its being followed further in this direction, but at the headwaters of Sturgeon, Sexton, and Island creeks, where Jackson, Owsley and Clay counties join, a coal was noted which had about the position of this seam and is provisionally correlated with it.

A coal was also noted at the top of the high ridges, heads of Lineman, Pappaw, and Buffalo creeks, confines of Owsley, Lee and Breathitt counties, which may be at the horizon of the Jellico. It ranges here somewhere in the neighborhood of 48 inches thick.

Clays were noted in various parts of the field. Those in the vicinity of Pine Hill, in Rockcastle county, have been tested and found to possess some commercial value, and some have been shipped.

The opportunity for finding valuable fireclay at the base of the Coal Measures will increase as the margin of the field is traced northward, for its development seems to be correlated with the development of an unconformity which increases in amount northward.

Iron Ore occurs at the base of the Coal Measures near the tops of the ridges, from the headwaters of Slate and Beaver creeks, tributaries of Licking, to the Kentucky river. It occurs just on the top of the Lower Carboniferous Limestone; is of excellent quality, though low grade as regards iron content; was the main basis of the iron industry in Kentucky at a period of industrial development when she ranked "fourth" State in the production of iron in this country; and may again be worked when conditions more favorable to smelting of low grade ores occur again, as they probably will.

Natural Gas.—The supplies of gas which are piped to Mt. Sterling, Winchester and Lexington, come from some 43 wells drilled on Leatherwood and other forks of Indian creek, on Spaas creek, Short creek, and Right Fork of Cane creek, all tributaries of Red river, and on Hawkins branch and Petre Trace branch of Slate creek. Some of these wells are in Menefee and some in Powell county. They all start, so far as I was able to observe, in the Waverly formation, and strike the gas in the magnesian limestones which closely follow in descending order the Black Shale.

Oil.—The oil of the Irvine field, obtained from shallow wells along the Kentucky river at the mouth of Cow creek, also comes from about the same horizon as the Menefee gas. The wells start in the Black Shale.

Very respectfully,

ARTHUR M. MILLER.

APPENDIX II.

Summary of Report on the Region Drained by the Three Forks of the Kentucky River.

BY JAMES M. HODGE.

The drainage area of the Three Forks of the Kentucky river, in the southeastern part of Kentucky, includes the whole of Breathitt, Perry and Leslie counties, the greater parts of Lee, Knott, Letcher and Owsley counties, and small parts of Wolfe, Harlan, Jackson, Knox and Bell counties; in all about 2,800 square miles or nearly 1,800,000 acres.

The whole region is occupied by narrow crooked valleys or ravines and steep hillsides terminating in narrow, serrated ridges as tortuous as the valleys. The fall of the larger streams is exceedingly slight, Hazard in Perry county and Hyden in Leslie marking approximately the heads of navigation on the North and Middle Forks. To a large degree, the fall of all the streams increases in proportion as their volume diminishes. Such branches everywhere are torrential, but the rise three miles from the head of any stream rarely exceeds 150 feet per mile. The hills, ordinarily 200 to 400 feet high about the junction of the forks and west of South Fork, increase in average height in going up stream until the maximum is reached in Pine Mountain and Kentucky Ridge, at the heads of the forks, each about 1,000 feet above the main drainage. The extremes above sea level are at Beattyville, at the mouth of South Fork, elevation 640, and the top of Pine Mountain, elevation about 2,800.

Valleys and hillsides all were originally covered with a heavy growth of fine timber, but most of the lighter woods, poplar principally, have been floated to market. Of the heavier woods, black walnut is practically gone, and a

beginning has been made in marketing white oak, especially in the northern part of the region.

Farms have been cleared along the valleys almost continuously on all but the smallest streams, and the clearings extend well up the hillsides, not infrequently to their tops. After a few years of cultivation the rich soil of the steep hillsides is washed off, the fields are abandoned and new ones cleared. Occasional broad benches high on the hills give farms of easier slope, unseen from the roads along the main streams. Notwithstanding all this, there remains on the waters of the North and Middle Forks an immense area, more than half the acreage probably, rich in hardwood timbers, and with a considerable quantity of valuable soft woods. On the South Fork the proportion of timber land is less, perhaps one-third the average.

The geological range of the region is from the Subcarboniferous limestone (and associated sandstones and shales) at river level at Beattyville up some 1,500 feet* into the Coal Measures, as shown in outcrop along the river up to the top of Kentucky Ridge.

The Coal Measures extend unbroken up against the northern face of Pine Mountain, but the face gives an exposure of Devonian rocks at the base of the mountain up to the Lower Conglomerate at its top. The uplifting of this mountain resulted in a fault of over 1,000 feet, and broke the continuity of the coalfield, which otherwise would have extended without interruption southward into Virginia. Strata dip in this mountain southeast, generally nearly coincident with its southern face, but often at a much greater pitch.

Elsewhere throughout the region, with little exception, the dip is toward the center of a basin about a mile south of Jackson, Breathitt county. The chief exception is found south of Manchester, Clay county, where a slight southward dip obtains. The average rate of dip nowhere exceeds 1 per cent.

*No attempt has been made to determine this with accuracy.

and the maximum rate is probably below 3 per cent. except in such sharp flexures, or local rolls, as are common to all nearly level coal regions.

There are in this region about twenty distinct beds of coal, of which over half are of workable thickness, varying from three feet of clean coal up to over nine feet without parting, though all beds are apt to be more or less injured by partings. Cannel coal appears in at least eight beds, and some of them with considerable persistence.

Following are traced in brief outline the principal deposits of coal so far discovered.

Beattyville Coal Bed.—The lowest coal of the region is that mined at Beattyville during the last forty-five years, more or less, and more recently along the river above and below Beattyville. It lies near the base of the Lower Conglomerate measures, about 30 feet above the river at Beattyville, and, but for the insignificant area there cut out by the river, and Pine Mountain, it underlies the whole region. Where mined near Beattyville it has been found generally 3 to 5 feet thick, but it sometimes runs below workable limit.

It sinks below drainage at St. Helens, at the junction of North and Middle Forks, and farther up these streams its depth below them is governed not only by their fall and the dip of strata, but largely by the increase in thickness of Conglomerate measures overlying the coal.

While this would probably result in carrying the coal within a few miles up those two forks to a depth prohibitive of mining for many years to come, the case differs on the South Fork. There the strata rise with the stream, and there is reason to believe that the bed may be found of workable thickness at moderate depth below drainage as far up as Manchester and perhaps beyond.

This coal stands well in the market as a steam and domestic coal, after long use especially in Richmond and other towns of Central Kentucky.

Rockhouse Coal Bed; Manchester Coal; "Coal No. 1."*—

This bed is in this region the first above the Conglomerate Measures. It is below drainage throughout most of the region, but has outcrops near the bases of hills in Wolfe, Lee, Letcher, Owsley and Clay counties. In the first two it is worked for some extent for local use though rarely more than three feet thick and generally less. In Letcher, above and below Whitesburg, it runs from 3 to 5 feet in thickness of coal, and is nearly uniform, at $3\frac{1}{2}$ to 4 feet clean, on Upper Rockhouse creek.

In Clay county it is largely used for local needs, especially in the vicinity of Manchester, where it runs 3 to 4 feet thick without parting. It supplied fuel for many years to the salt works operated on Goose creek.

As in Northeastern Kentucky, the coal seems to be remarkably pure, and especially as regards sulphur. The quality of coal is perhaps more uniform in this bed than in any other of the series.

River Hill Coal Bed; Elkhorn Coal; Coal No. 3.—This bed, lying 150 feet to 200 feet above the preceding, known as the River Hill Coal in the vicinity of Jackson, was mined there in earlier times and transported to Central Kentucky by boats and rafts. Operations upon it were renewed with the introduction of railroad carriage. From the mouth of Quicksand creek, where the bed is at river level, northward through Wolfe county, where the bed is near the tops of the hills, it varies in thickness of coal from $2\frac{1}{2}$ to $3\frac{1}{2}$ feet, with a parting of from 2 to 12 inches.

With some doubt as to correlation, it is probably the same as the Elkhorn bed which, rising above drainage on Carr fork at the mouth of Defeated creek, with about $3\frac{1}{2}$ feet of coal there, carries 8 feet or more of coal, with slight parting, over onto Elkhorn creek, Pike county.

In Letcher county, below Whitesburg and on the South Fork, so far as known, the coal is thin.

The great value of the Elkhorn coal for coking has been made known by much investigation since the discovery of its coking property by a member of the State Survey in 1883. This, combined with the great thickness and excellent quality of the coal, makes the field probably the most important in the state. While the River Hill coal will make coke it does not yet appear that it is particularly well adapted to that purpose.

Fifty to eighty feet below the Elkhorn coal, in the Upper North Fork region, is a bed of clean coal 3 to 4 feet thick of considerable value in that region. Elsewhere it appears to be thin, except possibly in pockets on the Middle Fork.

Whitesburg Coal Bed.—This bed, like the preceding, has been found of workable thickness in a relatively small area only in the vicinity of Whitesburg, where it ranges from 3 to 5 feet thick, without parting. It is not unlikely that its further exploitation may develop additional areas of value, but over much of the region it is too much cut up with partings or is thin. It is mined opposite Whitesburg, yielding much splint coal, and all of excellent quality for the domestic use which it serves. Its roof is usually black slate.

Hyden Coal Bed; Sisemore Coal Bed; Fireclay Coal Bed; Coal No. 4.—This bed is the best known bed of the region, owing in part to its thick coal at convenient height in many places, and in part to its commonly carrying a flint fireclay parting by which it is readily identified. The bed lies about 60 feet above the preceding and 300 feet above the Elkhorn bed.

First seen with characteristic parting on North Fork waters, on Lost creek and 30 feet high at the mouth of Cockerel fork, it has there but 3 feet of coal, the parting injuring it seriously. Near the mouth of Lots creek, and on the river below, it is 3 to 4 feet thick, without parting or with parting inconsequent. A few miles up Lots creek it changes to cannel coal before going below drainage.

From Lots creek up the river to Sasafras creek, Carr fork, it ranges from over 3 feet to over 4½ feet of coal, rising from 50 feet above the river to 150 feet above Carr fork.

From Sasafras creek westward to the heads of Rockhouse and Millstone the bed carries 3½ to 5½ feet of coal, sometimes in part a fine cannel. On millstone it lies 400 feet above the creek. On the west side of the North Fork the 5 to 5½ feet coal of Lick branch (above Lost creek); the 20 inches of coal on 14 inches of cannel of Georges creek; and the 88-inch coal of Wolf creek, all without parting, and the 5-foot coal of Long's creek, are referred with some question to this bed.

On Mace's and Leatherwood creeks and Line fork the bed has usually 3 to 3½ feet of coal, with parting on Line fork forming its floor and 3 feet of coal above it. Near the head of this fork it is below drainage.

On Cutshin creek and on Middle fork and its waters above Cutshin the bed has generally 3 to 3½ feet of workable coal. At Hyden, where it is called the Sisemore coal, the bed is about 5½ feet thick including the 7-inch fireclay parting. The coal is lowered 200 feet from the mine on an incline ending on the main street of the town.

On Red Bird creek it has 4 to 3 feet of coal, but where thickest one or two thin partings appear in addition to the usual fireclay.

Too high in the hills to be of much value on Goose creek except near the head, it is there (with some uncertainty as to correlation) over 4 feet thick without parting. In quality the coal is quite uncertain, though generally good for steam or domestic use and sometimes particularly fine. It is usually in part splint coal, and sometimes part cannel. On Lots creek, Breathitt county, and again on Greasy creek, Leslie county, it has been found wholly cannel.

Rider to Fireclay Coal.—This bed is chiefly important because of its proximity to the bed just described. Though sometimes absent, it is often found 5 to 20 feet above the Fireclay coal, especially in Leslie county, and there, on Beech fork, has 38 inches, solid, of cannel coal. It is also workable on Lots creek, Perry county.

Haddix Coal Bed.—This bed, so far as yet known, has comparatively little workable area. At the mouth of Troublesome creek, above Jackson, it has 4 feet of exceptionally fine

cannel. In the high ridge between lower Troublesome and South Quicksand creek it has nearly 5 feet of coal, and on Lost creek it appears to range from $3\frac{1}{2}$ feet near the mouth to 4 feet at the head, though perhaps under 3 feet in places. Beyond the ridges about Lost creek the coal, where identified, is either thin or badly separated by partings. It is a difficult bed to find, and is less known than those below it.

Owing to its remarkable purity and to its carrying cannel or semi-cannel coal through a large part of its area, and because of its nearness to railroad, it is likely to find early development and favor in the market. It was well known in Central Kentucky before railroads superseded transportation down the river.

Hazard Bed.—This bed is one of the most regular of the region and may be counted upon generally to carry about 5 feet of coal, but as it lies about 300 feet above the Fireclay coal its area is considerably restricted.

Flint ridge, between South Quicksand and lowed Troublesome creeks, contains a working area of it farthest north, Southward, in Breathitt county, it has workable areas mostly well up in the main ridges. Toward the head of Lost creek and near drainage level it has over 7 feet of coal, and on the head of Long or Trace fork of Buckhorn, also low in the hill, it has 100 inches, its maximum thickness probably.

The principal openings in Knott county are at the mouth of Dans fork of Buckhorn, 7 miles above Long fork, coal nearly 5 feet, and near Hindman, coal $3\frac{1}{2}$ feet. At the latter place an aerial tramway delivers the coal into the valley from a height above the creek about 460 feet, but correlation is not fully determined.

In the northern half of Knott county but little exploration has been attempted, and in the southern half the bed is too high to have created much interest. In most of Letcher county its place is above the tops of the hills.

In Perry county the coal ranges from 4 to 5 feet thick with workable areas in all the principal ridges, and a large field of the coal about the heads of Leatherwood creek.

Along the eastern side of Leslie county the coal has been found 4 to $5\frac{1}{2}$ feet thick, the latter including 23 inches of cannel

coal on Laurel fork of Cutshin creek. Elsewhere on Middle Fork waters the bed is more or less broken up with partings, or the little search made for it has failed to show its better condition.

On Sugar creek, a branch of Red river, in Leslie county, the coal is 7 feet thick, but too high in the hill to be of present value. It gives ample areas southwards.

The coal seems to be fairly uniform in quality, with some appearance of being fit for coking, though sometimes carrying too much splint coal. It is generally a clean coal with little or no partings, and finds favor where used locally.

Flag Coal Bed.—This bed takes its name from the plates of cannel coal resembling flag-stones exuded from the outcrops about the mouth of Troublesome creek. But little is known of the bed elsewhere than in southern Breathitt county. It is 30 to 80 feet above the Hazard bed.

On lower Lost and Troublesome creeks it is about $3\frac{1}{2}$ feet, thick with a tendency to cannel coal in the bottom seam. On the head of Trace fork of Buckhorn creek it has 5 feet of coal. On the head of Irishman creek, what appears to be the same bed has 5 feet of nearly clean, bright coal, largely splint. And again on Mace's creek near its mouth nearly the same section. On the head of Leatherwood creek, Perry county, what is probably the same bed gives $3\frac{1}{2}$ feet coal.

The coal seems to make an excellent fuel, and the cannel, where it occurs, is particularly fine.

The Hindman Coal Bed.—This bed is given its name because of its great thickness, over 9½ feet of coal apparently without parting, near the town of that name, and on the Right Fork of Troublesome creek. The bed is here about 500 feet above the Fireclay bed, too near the top of the hill to be of value. On the divide between Big and Mace's creeks it shows a thick stain and probable working area. On Cutshin creek, near Hyden, it has 6 feet of coal near the top of a high peak.

Above Hyden there are good workable areas of the coal, with 7 feet thickness (correlation somewhat doubtful) on White Oak, a branch of Greasy creek, and about 5 feet on

ANALYSES TO ACCOMPANY

Labor'y No.	Name of Bed.	Location.	County.	Total Coal Inches.
2708	Beattyville	Sturgeon Cr.	Lee	47
2704	Beattyville	Sturgeon Cr.	Lee	34
2357	Rockhouse	Rockhouse Cr.	Letcher	44
2358	Rockhouse	Mouth of Sand Lick Cr.	Letcher	25†
2359	Rockhouse	Mouth of Sand Lick Cr.	Letcher	28†
2649	Manchester	Goose Cr.	Clay	39
2756	Elkhorn	Mo. of Little Carr	Knott	46
2352	Elkhorn	Laurel Br. North Fork	Letcher	96
2361	Elkhorn	Same opening; Lower seam	Letcher	70
	Elkhorn	Potters Fork	Letcher	83
	Elkhorn	Same, 48-hr. Coke	Letcher	
	Elkhorn	Same, 72-hr. Coke	Letcher	
2528	Fireclay Coal	Lost Cr.	Breathitt	24
2754	Fireclay Coal	Rockhouse Cr.	Letcher	c. c. 18
2753	Fireclay Coal	Millstone Cr.	Letcher	66
2737	Fireclay Coal	Rockhouse Cr.	Leslie	69
2735	Fireclay Coal	Greasy Cr.	Leslie	44
2647	Fireclay Coal	Indian Grave Br.	Clay	51
2739	Rider to Fireclay Coal	Beech Fork	Leslie	c. c. 38
2282	Haddix	Mo. Troublesome Cr.	Breathitt	c. c.
2530	Haddix	Russell Br.	Breathitt	58
2795	Haddix	Mo. Squabble Cr.	Perry	36
2735	Hazard	Mo. Dan Fork	Knott	58
2755	Hazard	Hindman	Knott	42
2738	Hazard*	Laurel Fk. Cutshin	Leslie	67
2737	Hazard	Laurel Fk. Cutshin	Leslie	c. c. 23
2733	Flag	15 Mile Cr.	Perry	86
2732	Flag	16 Mile Cr.	Perry	58

†Upper seam.

†Lower seam.

*Analysis of bituminous portion.

REPORT OF JAMES M. HODGE.

ANALYSIS.

Specific Gravity.	Moisture.	Volatile Comb. Matter.	Fixed Carbon.	Ash.	Sulphur.	Character of Coke.
1.345	4.16	38.97	49.24	7.63	1.97	Spongy
1.299	3.53	40.51	49.00	6.96	2.60	Spongy
1.242	1.46	35.84	58.60	4.10	1.068	Light Spongy
1.277	1.30	39.60	55.20	3.90	2.812	Light Spongy
1.286	1.60	36.40	56.60	5.40	1.060	Light Spongy
1.278	1.48	35.92	54.70	7.90	0.885	Spongy
1.367	2.92	34.90	54.36	7.82	0.65	Friable
1.291	3.26	32.24	61.60	2.90	0.656	Dense
1.319	2.86	31.54	62.10	3.50	0.535	Dense
	1.950	37.350	57.367	2.800	0.533	
	0.302	1.623	91.320	6.165	0.590	
	0.170	1.135	91.731	6.505	0.459	
1.366	1.40	35.90	52.50	10.20	3.483	Spongy
1.309	0.39	46.11	40.50	13.00	2.00	Dense
1.333	1.43	37.00	53.35	8.22	0.71	Spongy
1.279	0.74	36.06	54.00	9.20	1.307	Spongy
1.251	1.72	35.02	57.60	5.66	0.599	Spongy
1.288	1.10	35.60	56.90	6.40	0.885	Light Spongy
	1.10	44.20	43.70	11.00	0.690	Dense
1.212	1.60	46.60	46.80	5.00	0.824	Dense Spongy
1.345	3.80	35.60	54.80	5.80	0.875	Dense
2.257	1.90	37.10	57.90	3.10	0.749	Spongy
1.294	1.76	41.98	49.67	6.59	1.83	Dense Spongy
1.264	1.44	41.67	52.24	4.65	1.05	Spongy
1.290	1.67	38.78	53.91	5.64	1.34	Dense Spongy
1.225	1.56	46.94	45.16	6.34	0.72	Dense
1.337	2.48	35.51	52.43	9.58	1.05	Dense Spongy
1.299	2.09	38.61	54.21	5.09	0.83	Dense Spongy

APPENDIX III.

Abstract from Preliminary Report on the Field Work of the Soil Survey.

BY AUG. F. FOERSTE.

During the summer of 1907 a general survey of the soils of the Mississippian or Subcarboniferous areas of the western half of Kentucky was undertaken by the Kentucky Geological Survey. This work was placed in charge of Mr. Aug. F. Foerste, and he was very efficiently assisted by Mr. George F. Brockman and Mr. Graham Edgar.

The field work consisted in a careful collection of samples of soil over as wide an area as it was possible to cover in the time at disposal. Since it was not possible to cover the entire field thoroughly, a number of representative counties were studied in considerable detail, and the remainder were examined sufficiently to determine at least the most important characteristics of their soils. - With the continuance of the Survey, the work will be extended until all of the counties of the State have been covered.

During this preliminary investigation, the soils along the river and creek bottoms were excluded, since they represent the richest soils of the State and are highly productive under almost any system of cultivation. Here, soils resulting from the decay of many kinds of rocks have been commingled by wash during high waters, and the resulting mixture almost invariably contains every element necessary for plant growth.

The soils above the reach of high waters, on the contrary, have been formed by the decay of such rocks as happened to be exposed to the air within recent periods, geologically, there where the soils now are found. Along hillsides, where several kinds of rocks are exposed, the different soils formed by their decay may be washed by rains to lower levels, and more

or less commingled along the lower slopes, of the hills and on the immediately adjoining fields.

Along the more level fields, however, where the overwash due to rains is less considerable, the soils usually represent the materials which remain after the decay of the rocks of the immediate vicinity. For instance, a sandy soil indicates the former presence of a layer of sandstone, and a deep red clay soil in this part of the State usually indicates the former presence of a limestone.

It rarely is difficult to determine from what kind of rock any soil has been formed. If the original source of the soil was a layer of rock of any considerable thickness, usually enough of the rock remains, notwithstanding the decay of a great part of the same, to indicate the nature of the source. This is especially true of the lower part of the layer, since decay usually is greater near the surface of the earth, the lower parts of a layer of rock frequently being still quite fresh, while the upper and middle parts already have disintegrated into soil.

It is quite evident that if soils result from the decay of rocks, the chemical characteristics of soils are dependent largely upon the chemical constituents of the rocks from which they were formed. Moreover, where larger layers of rocks of considerable thickness may be traced for many miles across the country, similar soils may be expected to result from the decay of similar rocks. Therefore, it should be possible to secure an approximate idea of the characteristics of the soils of a county from a knowledge of the underlying rocks.

For this reason, the Survey has undertaken a study of the soils of the Mississippian or Subcarboniferous areas of Western Kentucky, and has attempted to show how the nature of these soils varies with the nature of the rocks from which the soils were derived.

The most obvious study of a soil consists of an investigation of its chemical characteristics. Investigations of this nature have been conducted by this and by former surveys of the State, but not in the systematic manner which it is hoped to inaugurate in all future work, especially in relation to the

connection between the characteristics of soils and the rocks from which they have been derived.

The fertility of a soil, however, depends not only on its chemical constituents but also upon its physical characteristics, whether the grain of the soil be coarse or fine, porous or rather impervious to rain, especially when more or less parched during a long drought. The capacity of a soil, not merely to take water, but to hold water in sufficient quantity, determines its availability for different crops. For this reason the physical study of a soil is as important as its chemical study, and it is intended to give this part of the subject also proper consideration.

The field study of soils consists in noting the different qualities of soils found in the different counties, and in determining from what geological formations these soils have been derived. As far as possible, the information already gathered by farmers and other practical men is sought and recorded.

The field study of a soil should contain at least the following information:

The exact location of every sample of soil studied. It should be possible, from the record, to determine not only the field, but the corner of the field from which the sample was collected, even in case that fence lines are changed, so that the study of the soil should have value not merely for one or two years, but for a much longer time.

On sloping hill surfaces, the elevation at which soil was collected, above creek or road level, often will assist in locating the exact spot from which the soil was obtained.

The number of points from which cores were taken in order to make up the sample should be designated, since, the greater the number of cores and the more these are scattered over the corner of the field selected for investigation, the better the sample will serve in giving the characteristics of the average soils from this locality. The method of sampling used will be described later.

It is a good idea to state by whom and when the soil was collected, since different treatments of soil may either enrich or impoverish the same, and a record of the date will give an idea as to the rate at which these changes are taking place,

in case future investigations of the same territory ever should be considered desirable. Even the time of the year and the condition of the field would add desirable information, since the quantity of soil entering the soil tube would be modified by condition of the field at the time of sampling, whether recently plowed, as in the case of a tobacco field, or long at rest, as in the case of a wheat or oat field after harvest. In the case of pasture land, long idle, the quantity of soil entering the soil tube would be much greater than in the case of a recently cultivated corn field.

The situation of the sampled soil, whether upon upland, or down in the valley, along hillsides, or in flat level fields, near stream courses, or far above the highest waters, should be noted, since this would indicate to what extent the soil would be liable to mixture with other soils from sources farther up the stream or hillside. Moreover, the amount of moisture which will enter a soil is determined to a considerable extent by the location of the field of which it is a part.

Of course, all physical characteristics of the soil which it is possible to discover by examination in the field should be recorded. This can often be done very readily, especially where the soil has been cultivated recently, but a considerable part of the physical examination of soils can be conducted more conveniently in the laboratory of the Survey, to which samples collected are sent.

The trees characteristic of the lands from which the soils have been collected often are an index of the value of the soils for different crops, and their presence or former presence should be recorded. Such information can often be secured from the farmers who have long lived in the neighborhood.

The best crops so far produced by the field, those for which the field appears best adapted and the average yield of the field during an average season are items which can be learned best from the farmer, but a certain skill in estimating the average yield of a field may be secured by examining the condition of the crops of this or adjoining fields, and this information should be used as a check in determining the reliability of the various reports received, in the few cases where such a check is desirable.

The extent to which fertilizers have been applied in the past should be noted, the different fertilizers used and their relative value for different crops should be recorded. In many cases, farmers who deny using fertilizers will be found using stable manure, not classing this under the name of fertilizers. There is much curious information current among certain farmers, which it is desirable to secure, in order that the reliability of this information may be tested by scientific methods. Many farmers believe that certain fertilizers may be advantageous in wet weather but positively harmful during a dry season. Others think that fertilizers are of value for one or two seasons and then leave the fields in worse condition than ever before. The basis upon which these conclusions have been reached should be ascertained and tested.

The length of time during which the soil tested has been under cultivation should be learned, since virgin soils contain considerable humus making the soil very fertile during the earlier years of its cultivation, and a comparison of virgin soils and old soils from the same immediate vicinity would serve to indicate some of the changes which may be expected in the future and might lead to suggestions as to methods of cultivation or of fertilization which would assist in either maintaining or improving the value of the soil studied.

It has been evident to the party, while in the field, that farmers are willing to welcome a practical study of their soils. Many expressed regret that in the short time at the disposal of the men, the soils belonging to their own fields could not be selected for study. But it was also quite evident that what these farmers wanted was not merely theoretical assistance, but practical assistance, such as a farmer could use in improving the productiveness of his soil. It is the intention of the Survey to provide such information.

The sampling of soil is done by means of a sampling tube. This consists of a steel tube, about an inch and a half in diameter, but with thin walls, similar to the thin walled tubes used for bicycles. Into the lower end of this tube is inserted a short piece of tubing with a smaller interior diameter, so that anything passing through the short piece of tubing at the

bottom of the sampling tube would lie rather loose within the walls of the sampling tube itself, and therefore would drop out of the upper end of the sampling tube if the latter were inverted. The short piece of tubing at the bottom of the sampling tube is filed on the outer margin so as to produce a sharp cutting edge at the bottom, thus making the driving of the tube in the ground a comparatively easy operation. The upper end of the sampling tube is inserted into a heavier piece of tubing so as not to suffer as much from the heavy blows of the mallet by means of which the tube is driven into the ground. This mallet consists of a massive piece of iron into the ends of which comparatively large pieces of wood may be inserted, this wood damaging the upper end of the sampling tube less than would the direct blows of an iron mallet. Provision is made also for the insertion of the wooden handle belonging to the mallet.

A part of the field having been selected for sampling, the cutting edge of the sampling tube is placed on the ground and the tube is driven into the soil, by means of the mallet, usually for a distance of six inches. Owing to a mark filed into the outer surface of the sampling tube, it may be readily determined when the tube has reached the proper depth. On drawing out the tube, the soil which has entered the tube does not drop out, being held sufficiently by that part of the soil which is held by the short cutting edge of the tubing inserted into the bottom of the sampling tube. On inverting the sample tube, however, most of the soil drops out, and the little which remains behind at the cutting edge may be readily pushed into the main body of the tube.

All of the soil secured as the result of driving the tube once into the ground is called a core. Such a core has a diameter of nearly an inch and a half, and a length of fully six inches. Walking a distance of about thirty feet, the tube is driven into the ground again, and a second core is secured. Usually 12 cores are taken, each 6 inches long, from different parts of the field, being careful not to commingle different kinds of soil, and all 12 cores are dumped into the same bag. Such a mixture is then called a sample, and this sample should represent the average characteristics of the soil of this field,

both chemically and physically. In some fields, including more than one quality of soil, more than one sample may be necessary, but it usually has been preferred to sample from fields in which only one quality of soil was present, in order that there should be no doubt as to the kind of soil being investigated.

All of the information secured concerning the soil being sampled is written out at the time the soil is being sampled, in duplicate, one copy being placed in the sample bag, and the second copy being retained for use in the office. A tag, tied to the outside of the bag, serves as a third means of identification, and both records and the tag bear the same field number, so that by no means can the former location of any sample of soil be in doubt.

Samples of soil secured by driving the tube down for distances of only six inches into the ground are called soil samples, and are believed to represent that part of the soil most affected by ordinary plowing. Whenever the sample tube is placed in a hole from which a six-inch core already has been removed, and is driven down to the eighteen-inch mark on the outside of the tube, it is evident that the tube then contains the twelve inches of soil which underlie the six inches nearest the surface of the ground. Six cores taken in this manner represent as much material as twelve cores driven down only to the six-inch mark. These six cores, secured by taking samples of the lower parts of the soil from every alternate hole resulting from the upper soil sampling, form the sub-soil samples. The value of the sub-soil sample consists in determining whether the sub-soil contains any ingredients which would be valuable in the soil. If so, this sub-soil could be made available by means of deep plowing.

DISBURSEMENTS OF THE APPROPRIATION.

Following is a statement of the Survey account as on December 6, 1907, according to the Director's Books:

1905. Balance December 6, 1905	\$ 718 87
Paid out in December, from 7th to 31st	272 95
Balance January 1, 1906	445 92
1906. Appropriation March 17, 1906	25,000 00
	\$25,445 92

Expended in 1906:	
Paid out 1st quarter	\$ 748 88
Paid out 2nd quarter	5,208 65
Paid out 3d quarter	11,487 80
Paid out 4th quarter	3,646 02
	\$21,091 35

Balance on January 1, 1907	4,354 57
1907. Appropriation available March 17, 1907	25,000 00
	\$29,354 57

Expended in 1907:	
Paid out 1st quarter	\$ 2,831 09
Paid out 2d quarter	2,729 78
Paid out 3d quarter	8,393 96
	\$13,954 83
	\$15,390 74

Paid out in October	\$ 2,371 58
Paid out in November	4,308 91
Paid out December 1 to 6	1,874 01
	\$8,554 50

Balance December 6	\$6,845 24
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KENTUCKY GEOLOGICAL SURVEY.

Estimated expenditures to March 17 1908:

Salaries -----	\$ 3,045 00
Field expenses -----	425 00
Cooperative mapping -----	2,607 00
Office -----	133 00
Museum -----	100 00
Laboratories -----	250 00
Freights -----	100 00
Sundries -----	185 00
	<hr/> \$6,845 00

Following is a statement of disbursements in detail, arranged according to the headings under which they fall in the distribution of allotments in the work of the Survey, from December 6, 1905, to December 6, 1907:

ON ACCOUNT OF GEOLOGY.

	1905.	Pay	Expenses.	Total
Dec. 28.	J. H. Gardner, December pay---	\$ 50 00	\$ -----	\$ 50 00
Dec. 28.	F. J. Fohs, December pay and expenses -----	120 00	17 95	137 95
1906.				
Jan. 10.	Schaeffer Art Co., Acc't. of Jan. 2; developing 13 photo plates, 65c; 6 doz. prints, \$3.00-----	-----	3 65	3 65
Jan. 31.	F. J. Fohs, pay for January--	120 00	-----	120 00
Jan. 31.	J. H. Gardner, 3-5 January pay	30 00	-----	30 00
Feb. 28.	F. J. Fohs, 1/2 February pay--	60 00	-----	60 00
Feb. 28.	J. H. Gardner, 3-5 Feb. pay--	30 00	-----	30 00
Mch. 31.	F. J. Fohs, balance February pay and pay for March-----	148 00	-----	148 00
Mch. 31.	J. H. Gardner, balance Feb. and Jan. pay, and pay for March -----	90 00	-----	90 00
Mch. 31.	S. A. Denny, pay for March, 1/2 month -----	30 00	-----	30 00
April 30.	F. J. Fohs, pay for April-----	120 00	-----	120 00
April 30.	J. H. Gardner April pay and expenses -----	100 00	43 90	143 90
May 7.	S. A. Denny, April pay and expenses -----	75 00	32 32	107 32
May 31.	F. J. Fohs, May pay and expenses -----	120 00	64 45	184 45
May 31.	S. A. Denny, May pay and expenses -----	75 00	43 20	118 20
June 4.	W. F. Pate, pay 6 days in May and expenses -----	24 00	1 29	25 29

KENTUCKY GEOLOGICAL SURVEY.

	1906.	Pay.	Expenses.	Total.
June 16.	A. M. Miller, pay for May, 1906, and expenses for May, 1905, omitted in former account	\$ 50 00	\$ 3 23	\$ 53 23
June 16.	J. M. Hodge, May pay and expenses -----	150 00	186 43	336 43
June 16.	J. H. Gardner, May pay and expenses -----	100 00	78 08	178 08
July 3.	A. F. Foerste, preparing report on Silurian and Devonian Clays, etc. -----	200 00	-----	200 00
July 3.	A. M. Miller, June pay and expenses -----	50 00	11 45	61 45
July 3.	S. A. Denny, June pay and expenses -----	75 00	47 45	122 45
July 5.	F. J. Fohs, June pay and expenses -----	120 00	49 66	169 66
July 5.	J. M. Hodge, June pay and expenses -----	150 00	153 97	303 97
July 5.	J. H. Gardner, June pay and expenses -----	100 00	116 10	216 10
July 23.	W. F. Pate, pay 6 days in June and June expenses -----	24 00	3 77	27 77
July 31.	J. H. Gardner, pay 25 days in July and expenses -----	83 33	26 19	109 52
July 31.	A. M. Miller, July pay and expenses -----	50 00	69 84	119 84
Aug. 3.	F. J. Fohs, July pay and expenses -----	120 00	68 38	188 38
Aug. 3.	S. A. Denny, July pay and expenses -----	75 00	56 45	131 45
Aug. 3.	A. R. Crandall, July pay and expenses -----	200 00	43 50	243 50
Aug. 3.	J. M. Hodge, July pay and expenses -----	37 50	25 98	63 48
Aug. 3.	A. F. Foerste, July pay and expenses -----	125 00	64 97	189 97
Sept. 1.	S. A. Denny, August pay and expenses -----	200 00	68 91	268 91
Sept. 1.	A. R. Crandall, August pay and expenses -----	100 00	62 88	162 88
Sept. 3.	F. J. Fohs, August pay and expenses -----	120 00	71 15	191 15
Sept. 8.	J. M. Hodge, August pay and expenses -----	150 00	53 55	203 55
Sept. 13.	L. N. Taylor, pay and expenses in August -----	9 00	10 75	19 75

1906.		Pay.	Expenses.	Total.
Sept. 13.	A. F. Foerste, August pay and expenses for August 1 to Sept. 8, inclusive -----	\$125 00	\$34 96	\$159 96
Sept. 13.	A. M. Miller, August pay and expenses -----	50 00	54 99	104 99
Oct. 1.	J. M. Hodge, Sept. pay and expenses -----	100 00	31 47	131 47
Oct. 2.	F. J. Fohs, Sept. pay and expenses -----	120 00	45 66	165 66
Oct. 5.	S. A. Denny, Sept. pay and expenses -----	100 00	75 20	175 20
Oct. 5.	A. M. Miller, Sept. pay and expenses -----	50 00	52 86	102 86
Oct. 5.	A. F. Foerste, Sept. pay and expenses -----	62 50	11 35	73 85
Oct. 30.	A. M. Miller, October pay -----	50 00	-----	50 00
Nov. 5.	J. M. Hodge, October pay and expenses -----	50 00	20 85	70 85
Nov. 5.	F. J. Fohs, October pay and expenses -----	120 00	50 15	170 15
Nov. 5.	A. F. Foerste, October pay 2-5 mo. and expenses -----	50 00	12 71	62 71
Nov. 10.	L. N. Taylor, pay and expenses in October -----	10 00	12 65	22 65
Dec. 5.	F. J. Fohs, November pay and expenses -----	120 00	15 10	135 10
Dec. 5.	A. M. Miller, November pay --	50 00	-----	50 00
Dec. 31.	A. F. Foerste, pay for 14 days in November (\$58.33) and expenses (\$31.72) -----	58 33	31 72	90 05
Dec. 31.	F. J. Fohs, December pay and expenses -----	120 00	26 59	146 59
Dec. 31.	J. M. Hodge, pay 1-5 November 4-5 Dec. and expenses Nov. 27-29 and Dec. 1-31 -----	150 00	57 63	207 63
1907.				
Jan. 4.	W. F. Pate, pay and expenses November and December, 1906 -----	38 00	15 82	53 82
Jan. 4.	A. R. Crandall, pay for November and December, 1-2 mo. 1906 -----	100 00	-----	100 00
Jan. 12.	A. M. Miller, pay for December 1906 -----	50 00	-----	50 00
Feb. 1.	J. M. Hodge, January pay and expense -----	75 00	75	75 75
Feb. 4.	F. J. Fohs, January pay and expenses -----	120 00	20 70	140 70

1906.		Pay.	Expenses.	Total.
Feb. 4.	S. A. Denny, January pay and notary fee -----	\$50 00	\$ 50	\$ 50 50
Feb. 4.	A. M. Miller, January pay----	50 00	-----	50 00
Mch. 1.	J. M. Hodge, February pay----	150 00	-----	150 00
Mch. 1.	F. J. Fohs, February pay and expenses -----	120 00	23 94	143 94
Mch. 1.	A. F. Foerste, February pay----	50 00	-----	50 00
Mch. 6.	S. A. Denny, February pay and notary fee -----	50 00	50	50 50
Mch. 6.	A. M. Miller, February pay----	50 00	-----	50 00
Mch. 30.	F. J. Fohs, March pay and expenses -----	125 00	75	125 75
Mch. 30.	A. F. Foerste, March pay 1-5 mo. -----	25 00	-----	25 00
April 2.	J. M. Hodge, March pay----	100 00	-----	100 00
April 2.	A. M. Miller, March pay----	50 00	-----	50 00
May 1.	F. J. Fohs, April pay and expenses -----	125 00	44 46	169 46
May 2.	S. A. Denny, April pay and notary fee -----	50 50	-----	50 50
May 2.	A. M. Miller, April pay -----	50 00	-----	50 00
May 31.	F. J. Fohs, May pay and expenses -----	125 00	1 35	126 35
May 31.	A. M. Miller, May pay-----	50 00	-----	50 00
May 31.	L. E. Nollau, 5 photo negatives and prints of minerals -----	-----	3 50	3 50
June 11.	A. F. Foerste, May pay-----	25 00	-----	25 00
June 29.	F. J. Fohs, June pay-----	125 00	-----	125 00
July 4.	A. R. Crandall, June pay -----	50 00	-----	50 00
July 4.	A. F. Foerste, June pay, 12 days -----	50 00	-----	50 00
July 4.	S. A. Denny, June pay -----	50 00	-----	50 00
July 4.	J. M. Hodge, May pay 1-3 mo. and June pay 1-3 mo. -----	100 00	-----	100 00
July 31.	A. M. Miller, pay and expenses June and July -----	100 00	62 90	162 90
July 31.	A. R. Crandall, July pay -----	150 00	-----	150 00
July 31.	F. J. Fohs, July pay and expenses -----	125 00	12 85	137 85
Aug. 30.	A. R. Crandall, August pay 7-8 mo. and expenses July 29 to Aug. 27 inclusive -----	175 00	62 10	237 10
Aug. 30.	F. J. Fohs, August pay and expenses -----	125 00	8 75	133 75
Sept. 3.	J. M. Hodge, August pay and expenses -----	75 00	15 05	90 05

1906.		Pay.	Expenses.	Total.
Sept. 16.	A. M. Miller, August pay and expenses July 29 to Sept. 4 inc.	\$ 50 00	\$111 80	\$161 80
Sept. 16.	A. G. Spillman, collecting large blocks of coal for museum including cost of getting out same and sampling coals for analysis and fuel value testing, June, July and August-----	-----	55 00	55 00
Oct. 1.	F. J. Fohs, September pay and expenses-----	125 00	2 50	127 50
Oct. 1.	H. D. Easton, pay and expenses for Sept.-----	75 00	39 37	114 37
Oct. 3.	A. R. Crandall, September pay	100 00	-----	100 00
Oct. 3.	J. M. Hodge, September pay---	90 00	-----	90 00
Oct. 3.	A. M. Miller, September pay---	50 00	-----	50 00
Nov. 2.	F. J. Fohs, October pay and expenses-----	125 00	11 50	136 50
Nov. 8.	A. R. Crandall, October pay--	50 00	-----	50 00
Nov. 8.	A. M. Miller, October pay---	50 00	-----	50 00
Nov. 27.	J. L. Stewart, making photographs of mine and mill interiors-----	-----	5 00	5 00
Nov. 29.	F. J. Fohs, November pay and expenses-----	125 00	14 92	139 92
Nov. 29.	A. M. Miller, November pay---	50 00	-----	50 00
Dec. 6.	J. M. Hodge, Nov. pay and notary fee-----	50 00	50	50 50
Total Dec. 6, 1905, to Dec. 6, 1907-----				\$11,088 01

SOIL SURVEY AND TESTING.

1907.		Pay.	Expenses.	Total.
Aug. 2.	A. F. Foerste, pay and field expenses for July-----	\$125 00	\$129 58	\$254 58
Aug. 2.	Geo. F. Brockman, pay and field expenses for July-----	50 00	40 00	90 00
Aug. 2.	Graham Edgar, pay and field expenses for July-----	58 08	56 34	114 42
Aug. 22.	Geo. F. Brockman, expenses Aug. 1-15-----	-----	41 23	41 23
Aug. 22.	A. F. Foerste, expenses July 31-Aug. 13-----	-----	94 70	94 70
Aug. 30.	G. F. Brockman, expenses Aug. 16-26 inclusive and pay Aug. 1-Sept. 1-----	50 00	62 05	112 05

1907.		Pay.	Expenses.	Total.
Sept. 3.	A. F. Foerste, expenses Aug. 13-27 inclusive and pay for Aug.	\$125 00	\$78 68	\$203 68
Sept. 3.	Graham Edgar, expenses and pay for August-----	75 00	143 03	218 03
Oct. 1.	G. F. Brockman, expenses Aug. 28-31 inclusive-----	-----	8 44	8 44
Oct. 12.	Graham Edgar, pay 4 days in Sept. and notary-----	10 25	-----	10 25
Nov. 2.	A. F. Foerste, pay 2-5 of Sept. and expenses Aug. 28-Sept. 2 inclusive-----	50 00	49 49	99 49
Nov. 8.	A. F. Foerste, pay for 2-5 Oct.	50 00	-----	50 00
Dec. 6.	L. K. Frankel, making blue prints of county maps 70 sq. ft. at 5c-----	-----	3 50	3 50
Dec. 6.	A. F. Foerste, pay for 2-5 Nov. and expenses Nov. 16 to Dec 1-----	50 00	35 84	85 84
Aug. 2.	Graham Edgar, pay and field expenses for July-----	58 08	56 34	114 42

Total to December 6, 1907-----\$1,386 21

MISCELLANEOUS MAPPING, DRAFTING, OIL AND GAS.

1905.		Pay.	Expenses	Total.
Dec. 28.	J. S. Shaw, (account mapping) pay for December-----	60 00	-----	60 00
1906.				
Jan. 31.	J. S. Shaw, one-half salary for January-----	30 00	-----	30 00
Mch. 31.	J. S. Shaw, balance pay for January-----	30 00	-----	30 00
Mch. 31.	J. S. Shaw, pay for March-----	60 00	-----	60 00
April 30.	J. S. Shaw, pay for April-----	60 00	-----	60 00
May 15.	J. S. Shaw, pay and expenses, April 30, May 10-----	17 37	45 85	63 22
July 3.	H. B. Pope, (account mapping) pay ½ June and expenses-----	25 00	2 65	27 65
July 3.	J. B. Hoeing, (account drafting) and petroleum, June pay---	125 00	-----	125 00
July 31.	J. B. Hoeing, July pay-----	125 00	-----	125 00
July 31.	C. C. Terry, Livery for H. B. Pope and party for July-----	-----	26 00	26 00
	H. B. Pope, pay and expenses for July-----	50 00	42 25	92 25

KENTUCKY GEOLOGICAL SURVEY.

1905.		Pay.	Expenses.	Total.
Aug. 3.	C. C. Terry, Board of H. B. Pope in July-----	-----	\$20 25	\$ 20 25
Aug. 3.	Dixie Jacob, Livery for H. B. Pope in July-----	-----	8 00	8 00
Aug. 3.	G. F. Brockman, rodman-----	\$ 25 00	40 10	65 10
Aug. 9.	W. W. Shelby, Jr., rodman-----	25 00	18 55	43 55
Aug. 9.	C. C. Terry, Board for Shelby, parts of days July 1-19 and July 26-31, inclusive-----	-----	20 00	20 00
Sept. 1.	J. B. Hoeing, August pay-----	125 00	-----	125 00
Sept. 3.	G. F. Brockman, pay and expenses (August)-----	25 00	41 70	66 70
Sept. 3.	H. B. Pope, pay and expenses (August)-----	50 00	102 15	152 15
Sept. 3.	Cerulean Springs Hotel, Board of H. B. Pope, August 28-31, inclusive-----	-----	4 05	4 05
Sept. 3.	R. R. Turney, Livery for H. B. Pope, August 27-31, inclusive-----	-----	12 00	12 00
Sept. 3.	W. W. Shelby, Jr., pay and expenses, August-----	25 00	30 55	55 55
Sept. 3.	R. S. Pool, board of W. W. Shelby, Jr., Aug. 27 to Sept. 1-----	-----	8 00	8 00
Sept. 8.	W. W. Shelby, Jr., expenses August 21-27-----	-----	6 85	6 85
Sept. 8.	W. W. Shelby, Jr., pay and expenses, September 3-----	1 65	3 40	5 05
Oct. 1.	H. B. Pope, pay and expenses for September-----	50	85 45	135 45
Oct. 1.	Howard Brame, Livery for H. B. Pope, and party, September-----	-----	17 50	17 50
Oct. 1.	J. P. Davis, board of H. B. Pope, 4 days in September-----	-----	4 00	4 00
Oct. 1.	G. F. Brockman, pay and expenses in September-----	1 00	8 25	9 25
Oct. 1.	J. B. Hoeing, September pay-----	125 00	-----	125 00
Oct. 30.	J. B. Hoeing, October pay-----	125 00	-----	125 00
Oct. 30.	J. B. Hoeing, expenses to Dayton, O., and return in re maps-----	-----	8 60	8 60
Nov. 5.	H. B. Pope, pay and expenses for October-----	50 00	68 15	118 15
Nov. 5.	W. E. West, pay as temporary rodman, in Oct., for H. B. Pope, and notary fee-----	-----	7 25	7 25

KENTUCKY GEOLOGICAL SURVEY.

1906.		Pay.	Expenses.	Total.
Nov. 5.	Joal Clark, pay as temporary rodman in Oct. for H. B. Pope, and notary fee-----	-----	\$ 7 25	\$ 7 25
Nov. 5.	J. P. Bowling, Board of H. B. Pope, in October-----	-----	8 75	8 75
Nov. 5.	Walter Armstrong, livery for H. B. Pope and party in Oct.-----	-----	13 75	13 75
Nov. 30.	J. B. Hoeing, pay for Nov.-----	125 00	-----	125 00
Dec. 5.	H. B. Pope, pay and expenses for November-----	50 00	69 20	119 20
Dec. 5.	Q. M. Curvey, board for H. B. Pope, in November-----	-----	11 00	11 00
Dec. 5.	Wallingford & Foster, livery for H. B. Pope and party in Nov.-----	-----	42 00	42 00
Dec. 31.	H. B. Pope, pay and expenses for December-----	50 00	15 70	65 70
Dec. 31.	J. B. Hoeing, December pay-----	125 00	-----	125 00
Dec. 31.	J. B. Hoeing, expenses to Barbourville, Pineville, &c., in December-----	-----	12 42	12 42
1907.	December-----	-----	-----	80 00
Feb. 1.	J. B. Hoeing, (pay for January-----	80 00	-----	80 00
Feb. 1.	J. B. Hoeing, sample sacks-----	-----	2 75	2 75
Feb. 1.	H. B. Pope, pay for January-----	50 00	-----	50 00
Feb. 1.	H. B. Pope, pay for February-----	50 00	-----	50 00
Mch. 1.	H. B. Pope, pay for February-----	100 00	-----	100 00
Mch. 1.	J. B. Hoeing, pay for February-----	125 00	-----	125 00
Mch. 30.	J. B. Hoeing, pay for March-----	-----	-----	-----
May 1.	J. B. Hoeing, pay and expenses for April-----	112 50	4 80	117 30
May 1.	P. S. Wilson, (draftsman) pay April 3-10 mo. at \$100.00-----	30 00	-----	30 00
May 31.	P. S. Wilson, pay for May-----	100 00	-----	100 00
May 31.	J. B. Hoeing, pay and expenses for May-----	125 00	4 70	129 70
June 11.	J. M. Dyer, services and expenses in running line of levels in Crittenden county in May-----	30 00	24 55	54 55
June 11.	W. J. Waller, services and expenses as assistant to J. M. Dyer-----	14 00	11 90	25 90
June 29.	J. B. Hoeing, pay and expenses for June-----	115 00	17 10	132 10
June 29.	P. S. Wilson, pay for June-----	100 00	-----	100 00
July 4.	W. W. Shelby, Jr. (oil well mapping), pay for June 1-2 mo. and expenses-----	25 00	58 50	83 50
July 4.	J. W. Norton, rodman, pay for June 1-6 mo. and expenses-----	4 17	14 80	18 97

KENTUCKY GEOLOGICAL SURVEY.

		Pay.	Expenses.	Total.
1907.				
July 4.	S. B. Price, rodman, pay for June 1-6 mo. and expenses----	\$ 4 17	\$14 76	\$ 18 93
July 31.	J. B. Hoeing, pay and expenses July -----	125 00	(3 00)	128 00
July 31.	P. S. Wilson, pay for July-----	100 00	-----	100 00
Aug. 2.	J. W. Norton, pay and expenses for July -----	25 00	23 93	48 93
Aug. 2.	S. B. Price, pay and expenses for July -----	25 00	22 88	47 88
Aug. 2.	W. W. Shelby, Jr., pay and expenses for July -----	50 00	74 38	124 38
Aug. 2.	Mrs. J. W. Pedigo (Glasgow), livery for W. W. Shelby, Jr. and party in July -----	-----	39 00	39 00
Aug. 2.	J. C. Jenkins, lodging and meals for W. W. Shelby, July 17 to 31 inclusive-----	-----	-----	-----
	Same for J. W. Norton, July 17th to 31st inclusive, less one meal -----	-----	-----	-----
	Same for S. B. Price, July 17th to 31st, inclusive, less one meal Lunch for team driver-----	-----	48 93	48 93
Aug. 17.	S. B. Price, pay and expenses Aug. 1, to 10 -----	8 34	19 07	27 41
Aug. 17.	J. W. Norton, pay and expenses, Aug. 1, to 10 -----	8 34	8 94	17 28
Aug. 30.	W. W. Shelby, Jr., expenses Aug. 9th to 24th inclusive and pay for August, (oil well Sur.) -----	50 00	137 73	187 73
Aug. 30.	J. B. Hoeing, pay for August -----	125 00	-----	125 00
Sept. 3.	P. S. Wilson, pay for August -----	100 00	-----	100 00
Sept. 17.	W. W. Shelby, Jr., expenses Aug. 28 to Sept. 2, inclusive and pay for 1-2 September, (oil well survey) -----	25 00	71 97	96 97
Oct. 1.	J. B. Hoeing, pay for September -----	125 00	-----	125 00
Oct. 3.	Wallace Newberger, for drafting and computing field notes, 1-2 mo. September -----	30 00	-----	30 00
Nov. 2.	J. B. Hoeing, pay and expenses for October -----	125 00	(19 75)	144 75
Nov. 29.	J. B. Hoeing, pay and expenses for November -----	125 00	(15 09)	140 09
Total, December 6, 1905 to December 6, 1906-----				\$5,121 69

OFFICE ACCOUNT.

		Total.
1905.		
Dec. 28.	James Mack, janitor, pay for December -----	\$25 00
1906.		
Jan. 11.	Roger Harp & Bro., account rendered Jan. : Oct. 11, 1905, mop, 45c.; Dec. 28, 1905, soap, 1 broom, 45c.; -----	90
Jan. 11.	Items from Director's account as follows: Nov. 7, 1905, rent to telephone no. 1012, for Aug., Sept., and Oct. \$3.00 and tolls, \$2.50 -----	5 50
	Jan. 9, 1906, P. O. Box rent, quarter ending Mch. 31 -----	1 00
	Jan. 10, 1906, rent to telephone No. 1012, Nov., Dec. and Jan. \$3.00 and tolls \$2.50 -----	5 50
	Jan. 10, 1906, rent telephone No. 1540 quarter ending March, 31 -----	6 00
Jan. 31.	Jas. Mack, pay for January-----	25 00
Feb. 28.	Jas. Mack, pay for February-----	25 00
Mch. 31.	Jas. Mack, pay for March-----	25 00
April 4.	Items from Director's account as follows:	
	Feb. 10, rent telephone No. 1012 for February \$1.00 and Jan. tolls \$1.45 -----	2 45
	Mch. 1, rent telephone No. 1012 for March, \$1.00 and Feb. tolls, \$2.85 -----	3 85
	April 2, P. O. Box rent, quarter ending June 30-----	1 00
	April 3, rent telephone No. 1012 for April-----	1 00
	April 3, rent telephone No. 1540, quarter ending June 30 -----	6 00
April 4.	J. M. Byrnes, account rendered Jan. 26., 250 letter circulars -----	2 50
April 18.	Items from Director's account as follows:	
	April 2, paid H. B. Pope, work in office Oct. 1, 1905 to April 1, 1906 -----	30 00
	April 9, telegram to Washington (Wilson) -----	40
	April 16, telegram to Cincinnati (Hodge) -----	25
	April 17, J. W. Norwood, account fee for notary commission for survey, \$2.00 and rubber stamp .25 -----	2 25
April 30.	Jas. Mack, pay for April -----	25 00
May 8.	Items from Director's account as follows:	
	April 26, telegram -----	39
	April 30, E. M. Collins, typewriting 5 3-4 days-----	5 75
	May 2, 2 telegrams -----	1 08
	May 2, rent telephone No. 1012 for May, \$1.00 and April tolls, \$0.70 -----	1 70
	May 2, telegram from Milton, Wis. -----	68
	May 5, H. B. Pope, work in office, April -----	5 00
	May 5, W. L. English, typewriting 1 1-2 day-----	1 50
	May 5, Rhoda Miller, typewriting 4 1-2 days -----	4 50

		Total.
1906.		
June 6.	Jas. Mack, pay for May -----	\$25 00
June 6.	F. G. McKay, pay 2-3 month of May -----	40.00
June 11.	Items from Director's account as follows:	
	June 1, H. B. Pope, work in office, May -----	5.00
	June 2, Eight telegrams -----	4.10
	June 6, One telegram -----	.55
	June 8, Rent telephone No. 1012, for June (\$1) and May tolls (\$1) -----	2.00
July 3.	F. G. McKay, Clerk, pay for June -----	60.00
July 3.	Items from Director's account as follows:	
	June 24, Telegrams, Two from Marion -----	.54
	July 2, Rent, Telephone No. 1012 for Quarter ending Sept. 30., (\$3.) and June tolls (\$1.15) -----	4 15
	July 2, Jas. Mack, janitor, pay for June -----	25.00
	July 2, Rent, Telephone No. 1540 for Quarter Ending Sept. 30., -----	6.00
	July 2, Rent P. O. Box, for Quarter Ending Sept. 30. -----	1.00
July 23.	Postage Stamps -----	30.00
July 31.	F. G. McKay, Clerk, pay for July -----	60.00
July 31.	Jas. Mack, Janitor, pay for July -----	25.00
Aug. 9.	Items from Director's account as follows:	
	July 5, telegram, Big Stone Gap -----	46
	July 6, telegram, Big Stone Gap -----	67
	July 11, telegram, from Morganfield -----	26
	July 11, telegram from Straight Creek -----	55
Aug. 9.	Items from Director's account as follows:	
Sept. 1.	Items from Director's account as follows:	
	Aug. 9, telegram to Beaver Dam -----	45
	Aug. 13, cash refunded State Geologist of Indiana, for express -----	90
	Aug. 28, drawing pens -----	30
	Aug. 31, telephone tolls for August -----	50
Sept. 1.	F. G. McKay, clerk, pay for August -----	60 00
Sept. 1.	Jas. Mack, janitor, pay for August -----	25 00
Sept. 3.	Roger Harp & Bro., account as follows:	
	Feb. 6, 1 duster, 40c, rub-no-more, 05c -----	45
	May 11, 1 broom, 35c; pearline, 10c -----	45
	Aug. 1, 1 broom, 30c; pearline, 10c; soap, 05c; Ivory soap, 10c -----	55
Sept. 13.	Fellmer Hoeing, inserting maps in Big Sandy report 6 1-2 days -----	8 00
Oct. 1.	F. G. McKay, clerk, pay for September -----	60 00

		Total.
1906.		
Oct. 1.	Jas. Mack, janitor, pay for September -----	\$25 00
Oct. 2.	Items from Director's account as follows:	
	Oct. 1, rent telephone No. 1012, for quarter ending December 31. -----	6 00
	Oct. 1, rent telephone No. 1540, for quarter ending December 31. -----	6 00
	Tolls on telephone No. 1540 in June -----	15
	Oct. 1, P. O. Box rent, for quarter ending December 31 -----	1 00
	Telegram to Louisville, September 29 -----	51
Oct. 9.	Transylvania Co.'s account as follows:	35
	April 30, box photo plates -----	7 50
	June 25, glass in frames for maps -----	25
	Sept. 15, trimming maps -----	60 00
Oct. 30.	F. G. McKay, clerk, pay for October -----	25 00
Oct. 30.	Jas. Mack, janitor, pay for October -----	10 00
Oct. 30.	Wallace Newberger, work in office and museum in Oct. -----	45
Oct. 30.	2 pads for stencil stamp, from Director's account -----	
Nov. 30.	Items from Director's account as follows:	89
	Nov. 1, 2 telegrams -----	65
	Nov. 1, telephone tolls for October -----	25
	Nov. 23, telegram to Middlesboro -----	40
	Nov. 30, telegram from Big Stone Gap (Nov. 26) -----	40
	Nov. 30, telephone tolls for November -----	60 00
Nov. 30.	F. G. McKay, clerk, pay for November -----	25 00
Nov. 30.	Jas. Mack, janitor, pay for November -----	7 00
Dec. 5.	Wallace Newberger, work during November -----	60 00
Dec. 22.	F. G. McKay, clerk, pay for December -----	25 00
Dec. 22.	Jas. Mack, janitor, pay for December -----	
Dec. 31.	Items from Director's account follows:	25
	Dec. 5, telegram to Louisville -----	49
	Dec. 26, telegram to Louisville -----	
	Dec. 31, P. O. Box rent, for quarter ending March 31, 1907 -----	1 50
	Dec. 31, telegram to Dayton, Ohio -----	25
	Dec. 31, telegram to New York, N. Y. -----	61
1907.		
Jan. 4.	Jas. M. Byrnes, account as follows:	85
	Aug. 28, 1906, 1,000 tags, 60c; glue 25c -----	3 00
	Jan. 2, 1907, 500 circulars -----	
Jan. 4.	Items from Director's account as follows:	
	Jan. 4, rent telephone No. 1012 for quarter ending March 31 -----	6 00
	Jan. 4, rent telephone No. 1540, for quarter, ending March 31 -----	6 00

	1907.	Total.
Jan. 4.	Roger Harp & Bro's. account as follows:	
	March 8, 1906, 1 Mop 40c, pearline 15c, 1 duster 40c	\$ 95
Feb. 1.	Jas. Mack, janitor, pay for January	25 00
Feb. 1.	F. G. McKay, clerk, pay for January	60 00
Feb. 4.	Items from Director's account as follows:	
	Feb. 2, ink pad	25
	Feb. 2, telephone tolls for January	1 90
Mch. 1.	F. G. McKay, clerk, pay for February	60 00
Mch. 1.	Jas. Mack, janitor, pay for February	25 00
Mch. 1.	N. D. Bentley, typewriting, &c., 4 days in February	5 00
Mch. 1.	Kaufman, Straus & Co., towels	5 25
Mch. 4.	Items from Director's account as follows:	
	Mch. 16, telegram to Greenville	65
	Mch. 1, towel roller bar	10
	Mch. 1, telephone tolls for February	65
Mch. 30.	F. G. McKay, clerk, pay for March	60 00
Mch. 30.	Jas. Mack, janitor, pay for March	25 00
Mch. 30.	Transylvania Co's. account as follows:	
	Feb. 14, Letter Scales	1 75
	Feb. 15, 2 pencils	20
Mch. 30.	N. D. Bentley, typewriting and copying reports for March	35 00
April 2.	Items from Director's account as follows:	
	March 30, P. O. Box rent, for quarter ending June 30	2 00
	April 2, rent telephone No. 1012, for quarter ending June 30	6 00
	April 2, rent telephone No. 1540, for quarter ending June 30	6 00
April 2.	Frazer & Bush, account for fixing electric lights, and 2 stand lamps in office	11 84
April 15.	Roger Harp & Bro's. account as follows:	
	June 17, 1 Broom 35c, 3 pkgs. pearline, 15c	50
	Feb. 13, 3 pkgs. pearline 10c, (28) 4 bars soap 20c, sapolio 10c	40
	Mch. 7, 6 bxs. rub-no-more 30c, 6 bars soap 20c, 1 broom 40c	90
	Mch. 7, 1 mop 40c, (14) 6 bxs. pearline 30c	70
April 15.	Transylvania Co's. account as follows:	
	Mch. 1, 1 quart ink	75
May 1.	F. G. McKay, clerk, pay for April	60 00
May 1.	Jas. Mack, janitor, pay for April (\$25), extra time in Museum (\$5), and washing office towels (50c)	30 50
May 1.	N. D. Bentley, typewriting and copying reports for April	35 00
May 2.	East Tennessee Telephone Co., tolls for April	2 85

	1907.	Total.
May 2.	Items from Director's account as follows:	
	April 1, 6 telegrams in April, Postal Tel. Co.	\$ 3 32
	May 1, telegram in April, Western Union Co.	25
May 2.	Jas. M. Byrnes, account as follows:	
	Feb. 26, stenographer's note books	50
May 31.	F. G. McKay, clerk, pay for May	60 00
May 31.	Jas. Mack, janitor, pay for May (\$25) and washing office towels (50c)	25 50
May 31.	N. D. Bentley, typewriting and copying reports in May	35 00
June 11.	Jas. M. Byrnes, printing corrections on letter heads	1 00
June 11.	Item from Director's account as follows:	
	June 4, telegram in May	25
June 29.	F. G. McKay, clerk, pay for June	60 00
June 29.	Jas. Mack, janitor, pay for June (\$25) and washing office towels (50c)	25 50
June 29.	N. D. Bentley, typewriting and copying reports for June	35 00
July 4.	East Tennessee Tel. Co., rent on telephone No. 1012, for quarter ending Sept. 30, (\$6) and June tolls (\$1.05)	7 05
July 4.	Fayette Home Tel. Co., rent on telephone No. 1540, for quarter ending Sept. 30	6 00
July 4.	Items from Director's account as follows:	
	June 26, rent P. O. box, for quarter ending Sept. 30	2 00
	July 1, telegrams for June	4 77
July 31.	F. G. McKay, clerk, pay for July	60 00
July 31.	Jas. Mack, janitor, pay for July (\$25) and washing office towels, (50c)	25 50
July 31.	N. D. Bentley, typewriting and copying reports for July	35 00
July 31.	Roger Harp & Bro's., account of July 1, as follows:	
	April 26, 4 boxes pearline 20c, 2 bars soap 20c, duster 50c	90
	June 22, 1 broom	40
July 31.	McClure & Bronston, account as follows:	
	Sept. 12, 1906, 1000 cards for card index	1 25
Aug. 2.	S. M. Brown, furnishing and fitting locks for book-cases	7 00
Aug. 2.	Items from Director's account as follows:	
	Telegrams in July	1 88
	Telephone tolls in July	1 50
Aug. 22.	L. K. Frankel, for making 51 blue-prints of county maps, 246 sq. ft. at 5c	12 30
	1 yard of tracing cloth	40
Aug. 30.	N. D. Bentley, copying and typewriting reports for August, 6 days	6 78
Aug. 30.	F. G. McKay, clerk, pay for August	60 00

1907.	Total.
Aug. 30. Jas. Mack, janitor, pay for August (\$25) and washing office towels (50c) -----	\$25 50
Oct. 1. F. G. McKay, clerk, pay for September -----	60 00
Oct. 1. Jas. Mack, janitor, pay for September (\$25) and washing office towels (50c) -----	25 50
Oct. 1. N. D. Bentley, copying and typewriting reports for September -----	35 00
Oct. 1. East Tenn. Tel. Co., rent of telephone No. 1012, for quarter ending Dec. 31 -----	60 00
Oct. 1. Fayette Home Tel. Co., rent of telephone No. 1540, for quarter ending Dec. 31 -----	6 00
Oct. 1. Items from Director's account as follows:	
Aug. 31, Western Union Tel. Co., telegrams in August	1 88
Sept. 1, East Tenn. Tel. Co., tolls in August -----	95
Sept. 27, P. O. Box rent, for quarter ending Dec. 31	2 00
Oct. 3. Jas. M. Byrnes, account as follows:	
Sept. 12, 4 clips -----	60
Sept. 21, 1000 pinch clips 90c.; 1 Letter Scale (\$3) ----	3 90
Sept. 21, 24 Desk Blotting Pads -----	1 00
Oct. 18. Items from Director's account as follows:	
Oct. 4, 2 boxes for shipping books -----	0 20
Oct. 4. Hauling boxes to office -----	25
Oct. 4, telephone message in September -----	25
Nov. 2. N. D. Bentley, copying and typewriting reports for October -----	35 00
Nov. 2. F. G. McKay, clerk, pay for October -----	60 00
Nov. 2. Jas. Mack, janitor, pay for October (\$25) and washing office towels (50c) -----	25 50
Nov. 8. Items from Director's account as follows:	
Oct. 30, telegram to U. S. Geological Survey, Washington -----	56
Nov. 5, East Tenn. Tel. Co., tolls for October -----	2 55
Nov. 5, Western Union Tel. Co., telegrams in October -----	1 56
Nov. 13. Postage Stamps -----	50 00
Nov. 29. F. G. McKay, clerk, pay and expenses for November -----	63 10
Nov. 29. Jas. Mack, janitor, pay for November (\$25) and washing office towels (50c) -----	25 50
Nov. 29. N. D. Bentley, copying and typewriting reports for November -----	35 00
Dec. 6. Jas. M. Byrnes, account as follows:	
Nov. 16, 6 bottles paste (\$1.50), 1000 fasteners (\$1.50)	3 00

1907.	Total.
Dec. 6. Western Union Telegraph Co's. account for November:	
Nov. 8, telegram to Columbus (Easton) (35c), (11) to London (25c) -----	\$ 0 60
Nov. 12, telegram to Louisville, (27c), to Washington D. C. (50c) -----	77
Nov. 13, telegram to Louisville (25c), to Washington, D. C. (83c) -----	1 08
Nov. 26, telegram to N. Y. C. (88c), Scranton, (70c) Chicago (45c), Washington, D. C. (68c) -----	2 71
Nov. 29, telegraph to Boston, Mass -----	1 00
Dec. 6. Item from Director's account as follows:	
Dec. 4, telephone tolls in November -----	25
Total, December 6, 1905, to December 6, 1907 -----	\$2,423 03

MUSEUM.

1906.	
Oct. 30. Item from Director's account:	
Paid Will Johnston and helper for moving cases -----	\$ 0 80
Dec. 5. Combs Lumber Co., partition built across end of Museum, and shelves -----	64 90
1907.	
Feb. 4. Combs Lumber Co., partition and shelving, (lumber and workmen) -----	76 98
Feb. 4. Item from Director's account:	
Two men, 1 day each, moving cases -----	2 50
Mch. 1. S. M. Brown, making 3 map cases (\$51.35) and making board for map (\$3) -----	54 35
Mch. 6. W. L. Maclean, repainting relief geological map of State, on account -----	15 00
April 2. Geo. F. Brockman, work in museum, March 19 to 30, inclusive -----	10 00
April 15. Harp Bro's. account as follows:	
March 18, 4 barrels -----	60
March 26, 4 barrels -----	60
April 15. W. L. Maclean, balance on repainting relief map of State	15 00
April 15. S. M. Brown, 2 map cases complete (\$33.50) and blocks (\$21.75) for specimens, and 8 boxes (\$5) -----	60 25
May 2. J. M. Byrnes, 4,320 card labels for specimens, 22 forms	28 25
May 2. Geo. F. Brockman, 16 2-3 hours, work in April -----	2 50
May 2. Wallace Newberger, drawing large "economic" geology chart -----	5 00
May 31. L. H. Ramsey & Co. lettering large geological relief map of State -----	60 00

1907.

June 11.	Item from Director's account:	
	May 28, W. W. Shelby, work in April-----	\$ 1 50
Aug. 17.	Item from Director's account:	
	Mose Holeman, labor, 1 day-----	1 50
	Total, December 6, 1905, to December 6, 1907-----	\$ 399 73

CHEMISTRY AND CHEMICAL LABORATORY.

1906.

July 2.	A. M. Peter, analyses to July 1-----	\$ 60 00
Aug. 13.	Chase Palmer, analyzing 14 coals-----	70 00
Oct. 1.	A. M. Peter, analyses to October 1-----	197 50
Nov. 5.	A. M. Peter, analyses in October-----	80 00
Dec. 5.	A. M. Peter, analyses in November-----	55 00
Dec. 5.	Combs Lumber Co., scales case, \$19.50, and broken glass in same replaced, \$1.25 (November)-----	20 75

1907.

Feb. 4.	A. M. Peter, analyses to February 1-----	25 00
Mch. 6.	A. M. Peter, analyses to Mch. 1-----	182 50
May 2.	Geo. F. Brockman, ½ month in April, pay-----	12 50
May 31.	McAdams & Morford, Chemical Supplies-----	2 25
June 11.	Geo. F. Brockman, testing coals, 1 month, May-----	25 00
June 29.	Geo. F. Brockman, testing coals, 1 month, June-----	25 00
June 29.	Wallace Newberger, compiling new Chemical Bulletin, 1-10 month, June-----	6 00
July 4.	F. E. Tuttle, account of chemical analyses, for June-----	50 00
July 31.	W. Newberger, Compiling new Chemical Bulletin, July-----	60 00
Aug. 2.	A. M. Peter, for thermometer to replace broken one, (\$9.00) chemicals, (\$6.00) and expressage, (85c), ac- count fuel testing-----	15 85
Aug. 17.	F. E. Tuttle, chemical analyses, July-----	50 00
Aug. 30.	Wallace Newberger, drafting & compiling new Chemical Bulletin, August-----	60 00
Aug. 30.	F. E. Tuttle, chemical analyses, August-----	50 00
Sept. 3.	Standard Calorimeter Co., (E. Moline, Ill.) Aug. 24, 1 Calorimeter, electric ignition, and chemicals-----	153 25
Nov. 27.	Queen & Co., account as follows: Nov. 11, 2 8-foot wall cabinets for laboratory, (\$144); 1 double section chemical laboratory table with slate top, (\$63)-----	207 00
Nov. 29.	A. M. Peter, chemical work in Nov.-----	50 00
Dec. 6.	Lexington Plumbing Co., account of Dec. 4, 1 No. 6 Crescent Instantaneous water heater for labora- tory-----	20 00

1907.

Dec. 6.	Queen & Co., account, Dec. 5. (second shipment): 1 double section laboratory table-----	\$ 63 00
Dec. 6.	Eimer & Amend. (New York) account for Chemicals (Dec. 4)-----	56 01
Dec. 6.	Eimer & Amend. (New York) account for Apparatus (Dec. 4)-----	679 33
	Total, December 6, 1905, to December 6, 1907-----	\$2,275 94

TECHNOLOGY OF CLAYS, ETC.

1907.

Aug. 30.	H. D. Easton, pay and field expenses for August, 26 days-----	\$112 42
Nov. 8.	H. D. Easton, pay for October and notary fee-----	75 25
Nov. 29.	H. D. Easton, pay and traveling expenses for November-----	90 20
	Total for 1907, to December 1-----	\$ 277 87

TESTING LABORATORY EQUIPMENT.

1907.

Aug. 22.	Blake Mining & Milling Co., (Denver, Colo.): 1 static electric ore testing machine-----	\$ 77 03
Oct. 3.	The Black Sand & Gold Recovery Co., (Chicago): Oct. 1, 1 Laboratory Electric Testing Machine, for test- ing ferruginous sands, sandstones, earthy iron ores, glass sands, &c.-----	100 00
Oct. 12.	R. V. Wagner Co., (Chicago): 1 Static generator for Blake-Morscher ore testing machine-----	150 00
Nov. 27.	Sturtevant Mill Co., account of Nov. 25: Laboratory apparatus for testing ores, coals and clays, and road materials; 1, 2 x 6 crusher-----	\$125 00
	1, 8 x 5 rolls-----	150 00
	1 sample grinder-----	100 00
	1 screening machine-----	50 00
		\$425 00
Nov. 27.	H. J. Caulkins and Co.: 1 "Revelation" pottery and brick kiln-----	\$175 00
	Accessories for same-----	50 00
		\$225 00
Nov. 27.	Henry Heil Chem. Co., account of Nov. 25: 1 Braun's combination kiln, for testing clays-----	\$75 00
	1 Braun's No. 26 furnace and gas burner for glazed ware, vitrifying clay and high heats, with combination motor-blower-----	87 50

1907.

1 Cary double muffle furnace No. 37 with Cary burner, 2 1-4 inches, and tank No. 102 -----	83 00
	\$245 50

Nov. 27. R. V. Wagner Co., (Chicago), account of Nov. 26: 1 Combination motor and belt, for operating static ore testing machine -----	65 00
Total, December 1905 to December 1906 -----	\$1,287 53

CHEMICAL AND TECHNICAL LIBRARY.

1907.

Oct. 12. Hill Publishing Co., Aug. 31, 3 Volumes Mineral Indus- try -----	\$ 13 50
Dec. 6. Jno. M. Greenway, Dec. 3, miscellaneous technical and chemical books -----	214 20
Total -----	\$ 227 70

GENERAL EQUIPMENT, REPAIRS, ETC.

Feb. 28. Keuffel & Esser Co., repairs on barometers in April, 1905, (delayed account) -----	\$ 4 50
June 5. Keuffel & Esser Co., account as follows: May 28, 1 compass, \$11.90; 1 boxwood scale, 30c; 1 protractor, 36c; 1/2-do. cross section books, \$2.63; 1 screw for target on No. 6260, 60c; 1 bronzed sight compass, \$5.80, and postage 10c -----	21 69
June 11. L. M. Prince, 10 yds. 42-inch. No. 38 Sup. Sup. Egg- shell mounted drawing paper, (June 2) -----	8 70
Nov. 10. Keuffel & Esser Co., account of Oct. 17: 1 qr. Whatman's paper, Royal Hot P, 1 A., (\$1.19); 1 dozen inks (4 colors), Higgins, (\$2.25); 1 card crow-quill pens, 35c -----	3 79
Oct. 9. Smith Premier Typewriter Co., 1 Desk, (No. 20, Cab- inet) -----	42 75
Oct. 30. McClure & Bronston, 2 Index Files and Fittings -----	8 95
Oct. 30. Smith Premier Typewriter Co., 1 Typewriter -----	90 00
Dec. 31. C. H. Bowen, No. 3 Burroughs Adding Machine -----	250 00
1907.	
Jan. 12. Eimer & Amend, account for apparatus, etc.* Hoskins furnace and blow pipe -----	\$ 46 00
Assay balance, weights & riders -----	123 22
Sample crusher, (Case) -----	35 00
Scales for fluxes -----	7 20

*This should have been charged to Chemical Laboratory.

1907.

Ruedorff Sand Bath -----	\$ 8 00
Mortars (Buck's and Agate) -----	14 15
Set of sieves -----	4 00
Dangler lamp -----	5 00
Tongs, pliers, brushes, flasks, moulds, for- ceps, hammers, spatulas, magnifier, mag- net, pasteboard boxes, annealing cups, tri- angles -----	20 58
Chemicals -----	52 74

\$ 315 89

1907.

Feb. 4. Keuffel & Esser Co., drawing instruments, (Dec. 13, 1906) -----	\$ 6 62
Mch. 1. S. M. Brown, making 2 tables, (\$6.50) and 1 trestle, (\$2.75) -----	9 25
Mch. 6. Eimer & Amend, sample bottles, corks, sieves and cupels -----	6 35
Mch. 6. Keuffel & Esser Co., level rod -----	9 60
April 15. Keuffel & Esser Co., account as follows: Mch. 26, 2 qrs. Std. cross section paper No. 280 blue, \$4.90; 10 yds. plumb bob cord, 40c; 1 Aladdin reading lens, \$9.60; 1 renewal batty for same, 42c-- April 5, 2 Standards for mining lamp plummets-----	15 32 35 70 87 75
April 15. Smith Premier Typewriter Co., 1 Typewriter-----	70
April 15. Transylvania Co., 2 dozen photo. plates-----	
May 1. Southern Printers Supply Co., (Washington), 6 elec- trotype half tones -----	5 60 24 50
July 4. H. Pfister, repairing transit in June-----	
July 31. Smith, Watkins & Co., account of July 1: Mch. 29, screw driver bit 25c; nail puller 75c; 2 monkey wrenches \$1.90; 4 lbs. 4 penny nails 10c.--	3 05
Aug. 17. Item from Director's account: Brock & Co., tin tube for maps-----	1 00
Sept. 3. Keuffel & Esser Co., 1 roll mounted paragon paper 11-- 42 inches, \$6.51; 2 qrs. Whatman's paper No. 1 A, Imp. Hot., \$3 96; 1 roll Excelsior tracing paper 150--42 inches, \$10 60; 1 roll Corona tracing paper 195M--42 inches, \$2.53, on August 28-----	23 60 50
Nov. 8. T. B. Hay & Co., repairing tapeline on Nov. 1-----	
Nov. 29. Keuffel & Esser Co., account of Nov. 14: 1 measuring chain, \$5.60; 1 set steel arrows, \$1.13; 1 leather pouch for arrows, \$2.80; 1 champion band chain, \$7.50 -----	17 03

1907.

Dec. 6. Keuffel & Esser Co., account of Nov. 30:

1 Xylonite Protector, \$2 25; 1 hardwood Jacob staff
85c; 1 bow divider, 73c; 2-foot steel rule 34c, with
leather sheath, 4c; 1 dozen thumb tacks, 12c----- \$ 4 33

Total, December 6, 1905, to December 6, 1907-----\$ 997 17

FREIGHT AND DRAYAGE.

1906.		
Jan. 15.	Adams Express Co., bill Dec. 4, 1905 to Dec. 8, 1905---	\$ 1 95
Feb. 28.	Farley Transfer & Storage Co., bill of Jan. 1, freights and cartage on boxes of minerals-----	12 08
Mch. 26.	Adams Express Co., bill of July 12, 1905, (delayed bill) and Jan. 25, 1906-----	60
May 29.	Adams Express Co., bill April 28 to May 21-----	3 20
July 31.	Adams Express Co., bill May 31 to June 23-----	2 80
Sept. 1.	Adams Express Co., bill July 30 to Aug. 15-----	2 00
Oct. 30.	J. E. Risque, hauling April 13 to Oct. 8-----	7 84
Nov. 5.	Adams Express Co., bill Aug. 30 to Oct. 31-----	2 90
Dec. 6.	Adams Express So., bill Nov. 12 to Nov. 28-----	1 65
Dec. 31.	J. H. Hostetter Transfer Co., drayage-----	2 41
1907.		
Jan. 2.	Adams Express Co., bill for December, 1906-----	4 75
Jan. 25.	Adams Express Co., bill for January-----	1 20
Mch. 1.	Adams Express Co., bill for February-----	35
Mch. 30.	Adams Express Co., bill Feb. 25 to Mch. 2-----	3 75
April 26.	Adams Express Co., bill Mch. 22 to April 24-----	6 80
May 28.	Adams Express Co., bill May 15-----	1 75
June 29.	Adams Express Co., bill for June-----	3 40
July 4.	J. H. Hostetter Transfer Co., freights and drayage, Jan. 11 to May 1, inclusive-----	24 96
July 26.	Adams Express Co., bill June 28 to July 11-----	2 00
July 31.	Farley Transfer & Storage Co., freights and drayage, Aug. and Dec., 1906 and February, 1907-----	4 33
Aug. 28.	Adams Express Co., bill Aug. 20 to Aug. 27-----	5 37
Sept. 3.	Farley Transfer & Storage Co., freights and drayage, for August-----	9 93
Sept. 28.	Adams Express Co., bill Aug. 29 to Sept. 13-----	4 45
Nov. 8.	J. H. Hostetter Transfer Co., freights and drayage, Sept. 16 to Oct. 4, inclusive-----	26 52
Nov. 29.	Farley Transfer & Storage Co., freights and drayage, Aug. 15 to Sept. 19, inclusive-----	35 88
Dec. 2.	Adams Express Co., bill Oct. 31 to Nov. 29-----	8 35
Total Dec. 6, 1905 to Dec. 6, 1907-----		\$181 22

DIRECTOR'S ACCOUNT.

1906.		
Jan. 11.	Railroad fares November and December, 1905-----	\$ 4 20
Jan. 11.	Items paid by Director, but carried to other ac- counts:	
	Nov. 7, 1905, telephone No. 1012, rent Aug., Dec. and Jan. (\$3), and tolls, (\$2 50), (to office account)-----	\$ 5 50
	Jan. 9, 1906, P. O. Box rent, quarter end- ing March 31, (to office account)-----	1 00
	Jan. 10, 1906, telephone No. 1012, rent Nov. Dec. and Jan. (\$3), and tolls, (\$2 50), (to office account)-----	5 50
	Jan. 10, 1906 telephone No. 1540, rent quar- ter ending Mch. 31 (to office account)-----	6 00
		\$ 18 00
April 4.	Pay, 14-31 of month (Act of 1906), \$11 29 and traveling expenses February and March, \$38.87, total-----	50 16
April 4.	Items paid by Director, but carried to other accounts:	
	Feb. 10, telephone No. 1012, rent for Feb- ruary, \$1, and January tolls, \$1.45, (to office account)-----	\$ 2 45
	Mch. 10, telephone No. 1012, rent for Mch., \$1, and February tolls, \$2.85, (to office account)-----	3 85
	April 2, P. O. Box, rent quarter ending June 30, (to office account)-----	1 00
	April 3, rent telephone No. 1012, for April, (to office account)-----	1 00
	April 3, rent telephone No. 1540, quarter end- ing June 30, (to office account)-----	6 00
		\$ 14 30
April 18.	Traveling expenses in April-----	57 65
April 18.	Items paid by Director, but carried to other accounts:	
	April 2, paid H. B. Pope, work in office, Oct. 1, 1905 to April 1, 1906, (to office ac- count)-----	\$ 30 00
	April 9, telegram to Washington, (Wilson) (to office account)-----	40
	April 16, telegram to Cincinnati, (Hodge), (to office account)-----	25

1906.

April 17, J. W. Norwood, account fee for Notary Commission, \$2, and rubber stamp, 25c, for Survey, (to office account)		\$2 25	
		\$ 32 90	
May 8.	Pay, for April, \$25, and railroad fares April 19 and May 4, \$4.90, total		\$ 29 90
May 8.	Items paid by Director, carried to other ac- counts:		
	April 26, telegram, (to office account)	\$ 0 39	
	April 30, E. M. Collins, typewriting 5 3-4 days, (to office account)	5 75	
	May 2, telegrams (Milton, Wis., 68c, Big Stone Gap, 40c) (to office account)	1 08	
	May 2, telegram from Milton, Wis., (to office account)	68	
	May 2, rent telephone No. 1012, for May, \$1 00 and tolls, March and part of April, \$0.70, (to office account)	1 70	
	May 5, H. B. Pope, work in office for April, (to office account)	5 00	
	May 5, N. L. English, typewriting 1 1-2 days, (to office account)	1 50	
	May 5, Rhoda Miller, typewriting, 4 1-2 days, (to office account)	4 50	
		\$20 60	
June 11.	Pay for May, (\$25), and traveling expenses in May (\$5.55), total		30 55
June 11.	Items paid by Director, but carried to other accounts:		
	June 2, 8 telegrams, on account of "Co-opera- tion" (to office account)	\$4 10	
	June 2, H. B. Pope, work in office, May, (to office account)	5 00	
	June 6, telegram to Washington, (to office account)	55	
	June 8, rent, telephone No. 1012, for June (\$1.) and tolls, April 22 to May 22, (\$1.) (to office account)	2 00	
		\$11 65	
July 3.	Pay for June		\$25 00
July 3.	Items paid by Director, but carried to other accounts:		
	June 24, 2 telegrams to Marion, (to office account)	\$ 0 54	
	July 2, Jas. Mack, janitor, pay for June, (to office account)	25 00	

1906.

July 2.	Rent, P. O. Box, for quarter ending Sept. 30, (to office account)	\$1 00	
	July 2, rent, telephone No. 1012, for quarter ending Sept. 30, (\$3.) and June tolls, (\$1.15), (to office account)	4 15	
July 2.	Rent, tel. No. 1540, for quarter ending Sept. 30, (to office account)	6 00	
		\$36 69	
Aug. 9.	Pay for July (\$25.) and railroad fares for July, (\$11.30)		\$36 30
Aug. 9.	Items paid by Director, but carried to other accounts:		
	July 5, telegram to Big Stone Gap, (to office account)	\$0 46	
	July 6, telegram to Big Stone Gap, (to office account)	67	
	July 11, telegram to Straight Creek, (to office account)	55	
	July 16, telegram from Morganfield, (to office account)	26	
	Aug. 3, telephone tolls for July, (to office account)	80	
		\$ 2 74	
Sept. 1.	Pay for August, \$25.) and traveling expenses for August, (\$1.95), total		26 95
Sept. 1.	Items paid by Director, but carried to other accounts:		
	Aug. 9, telegram to Beaver Dam, (to office account)	\$0 45	
	Aug. 13, cash, refunding express charges to State Geologist of Indiana, (to office ac- count)	90	
	Aug. 28, drawing pens, (to office account)	30	
	Aug. 31, telephone tolls for August, (to office account)	50	
		\$ 2 15	
Oct. 2.	Pay for September		25 00
Oct. 2.	Items paid by Director, carried to other accounts:		
	Oct. 1, telephone No. 1012, rent, quarter ending Dec. 31, (to office account)	\$6 00	
	Oct. 1, telephone No. 1540, rent, quarter ending Dec. 31, (to office account)	6 00	
	Oct. 1, tolls on telephone No. 1540, in June, (to office account)	15	

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Oct. 1, P. O. Box rent, quarter ending Dec. 31, (to office account) -----	\$1 00	
Oct. 1, telegram to Louisville (Sept. 29), (to office account) -----	51	
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	\$13 66	
Oct. 30. Pay for October -----		\$25 00
Oct. 30. Items paid by Director, carried to other accounts:		
Oct. 19, paid W. Johnston and helper for moving museum cases, (to museum account) -----	\$0 80	
Oct. 30, 2 pads for stencil stamps, (to office account) -----	45	
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	\$ 1 25	
Nov. 30. Pay for November, (\$25.) and traveling expenses, November, (\$11.70), total -----		36 70
Nov. 30. Items paid by Director, carried to other accounts:		
Nov. 1, 2 telegrams, (to office account) -----	\$0 89	
Nov. 3, telephone tolls for October, (to office account) -----	65	
Nov. 23, telegram to Middlesboro, (to office account) -----	25	
Nov. 30, telegram from Big Stone Gap (Nov. 26), (to office account) -----	40	
Nov. 30, telephone tolls for November, (to office account) -----	40	
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	\$ 2 59	
Dec. 31. Pay for December, (\$25.) and traveling expenses, December, (\$3.40), total -----		\$28 40
Dec. 31. Items paid by Director, carried to other accounts:		
Dec. 5, telegram to Louisville, (to office account) -----	\$0 36	
Dec. 26, telegram to Louisville, (to office account) -----	49	
Dec. 31, paid telegram to Dayton, Ohio (25c) and telegram to New York, (61c) (to office account) -----	\$0 86	
Dec. 31, P. O. Box rent, quarter ending Mch. 31, (to office account) -----	1 50	
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	\$ 3 10	
1907.		
Feb. 4. Pay for January (\$25.) and railroad fares for January (\$1.70), total -----		\$26 70

1907.

Feb. 4. Items paid by Director, carried to other accounts:		
Jan. 19, paid 2 men, 1 day each, for moving cases in museum, (to museum account) ---	\$2 50	
Feb. 2, ink pad for office, (to office account) -----	25	
Feb. 2, telephone tolls for January, (to office account) -----	1 90	
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	\$ 4 65	
Mch. 6. Pay for February -----		\$25 00
Mch. 6. Items paid by Director, carried to other accounts:		
Feb. 16, telegram to Greenville, Ky., (to office account) -----	\$0 65	
Mch. 1, towel roller bar, (to office account) -----	10	
Mch. 1, telephone tolls for February, (to office account) -----	65	
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	\$ 1 40	
April 2. Pay for March (\$25.) and railroad fares for March, (\$8.20), total -----		33 20
April 2. Items paid by Director, carried to another account:		
Mch. 30, P. O. Box rent, quarter ending June 30, (to office account) -----	\$2 00	
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	\$ 2 00	
May 2. Pay for April, (\$25.) and railroad fares for April, (\$1.70), total -----		26 70
May 2. Items paid by Director, carried to other accounts:		
April 30, Postal Telegraph Co., 6 telegrams in April (to office account) -----	\$3 32	
May 1, Western Union Telegraph Co., 1 telegram in April, (to office account) -----	25	
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	\$ 3 57	
June 11. Pay for May, (\$25.) and traveling expenses in May, (\$65.05), total -----		90 05
June 11. Items paid by Director, carried to other accounts:		
May 28, paid W. W. Shelby, Jr., for assistance in museum, (to museum account) ---	\$1 50	
June 4, paid Western Union Telegraph Co., telegram in May, (to office account) -----	25	
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	\$ 1 75	
July 4. Pay for June, (\$25.) and railroad fares in June, (\$3.40), total -----		28 40
July 4. Items paid by Director, carried to other accounts:		
June 26, P. O. Box rent, quarter ending		

1907.

September 30, (to office account) -----	\$2 00	
July 1, telegrams during June, (to office account) -----	4 77	
	<u>\$ 6 77</u>	
Aug. 17. Pay for July, (\$25.) and traveling expenses in July, (\$17.40), total -----		\$42 40
Aug. 17. Items paid by Director, carried to other accounts:		
July 30, Western Union Telegraph Co., telegrams in July, (to office account) -----	\$1 88	
July 30, Brock & Co., tin tube for map, (to equipment account) -----	1 00	
July 30, telephone tolls in July, (to office account) -----	1 50	
July 30, Mose Holeman, labor in museum, (to museum account) -----	1 50	
	<u>\$ 5 88</u>	
Sept. 3. Pay for August (\$25.) -----		25 00
Oct. 1. Pay for September (\$25.) -----		25 00
Oct. 1. Items paid by Director, carried to other accounts:		
Aug. 31, Western Union Telegraph Co., telegrams in August, (to office account) -----	\$1 88	
Sept. 1, East Tennessee Telephone Co., telephone tolls in August, (to office account) -----	95	
Sept. 27, P. O. Box rent, for quarter ending December 31, (to office account) -----	2 00	
	<u>\$ 4 83</u>	
Oct. 18. Traveling expenses in October, as per Auditor's book -----		31 37
Oct. 18. Items paid by Director, but carried to other accounts:		
Oct. 4, 2 boxes for shipping books, (to office account) -----	\$0 20	
Oct. 4, hauling boxes to office, (to office account) -----	25	
Oct. 4, telephone message in Sept., (to office account) -----	25	
	<u>\$ 0 70</u>	
Nov. 8. Pay for October -----		25 00
Nov. 8. Items paid by Director, carried to other accounts:		
Oct. 30, telegram to U. S. Geo. Survey, Washington, D. C. (to office account) -----	\$0 56	
Nov. 1, T. B. Hay & Co., repairing tape line (to Gen. Equip. and Repairs) -----	50	

1907.

Nov. 5, East Tennessee Telephone Co., tolls for October, (to office account) -----	2 55	
Nov. 5, Western Union Telegraph Co., telegrams in October, (to office account) -----	1 56	
	<u>\$ 5 17</u>	
Dec. 6. Pay for November, (\$25.) and traveling expenses in November, (\$6.20) -----		\$31 20
Dec. 6. Items paid by Director, carried to other accounts:		
Dec. 4, telephone tolls in November, (to office account) -----	\$0 25	
	<u>\$ 0 25</u>	
Total field expenses and pay, Dec. 6, 1905, to Dec. 6, 1907 -----		<u>\$785 93</u>
Total items paid and carried to other accounts, Dec. 6, 1905, to Dec. 6, 1907 -----		<u>\$196 60</u>

TOPOGRAPHIC MAPPING IN CO-OPERATION WITH U. S. GEOLOGICAL SURVEY.

1906.			\$ 75 09
May 8.	C. H. Semper, expenses for April -----		
May 31.	L. E. Tucker, expenses May 10-17, \$13.05, and May 6-16, \$26.55 -----	39 60	
May 31.	R. W. Berry, pay roll for May -----	282 49	
May 31.	L. S. Smith, pay roll for May -----	197 33	
May 31.	C. H. Semper, levelman, pay for May -----	100 00	
June 4.	J. R. Ellis, pay roll for May -----	98 83	
June 4.	J. R. Ellis, pay for 5 days in May -----	16 67	
June 16.	L. S. Smith, expenses May 8-31, \$303.16, and May 10, 11, 19, \$4.15 -----	307 31	
June 16.	Scott & Scott, livery for L. S. Smith in May -----	36 00	
June 16.	G. D. Wilson, livery for L. S. Smith in May -----	45 00	
June 16.	R. W. Berry, expenses in May -----	80 67	
June 16.	Capital Hotel, (Morganfield), subsistence of R. W. Berry and party, in May -----	273 00	
June 16.	Cambron & Clements, livery for R. W. Berry in May -----	22 45	
June 16.	J. C. D. Hapgood, livery for R. W. Berry party in May -----	100 50	
June 16.	J. R. Ellis, expenses May 10 to 17 -----	78 02	
June 16.	W. J. Lloyd, expenses May 26 to 28, \$33.40, and subsistence, May 28 to 31, \$5.25 -----	38 65	
June 19.	J. R. Ellis, services 16 days, \$53.33 and expenses in May, \$160.15 -----	213 48	
June 19.	Geo. T. Hawkins, pay for June, 1-2 month -----	91 67	

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July	6.	E. L. McNair, pay and subsistence roll for June -----	\$157 00
July	6.	L. S. Smith, pay and subsistence roll for June -----	605 00
July	6.	Phoenix Hotel, L. S. Smith's board, 11 days in June ----	27 50
July	6.	G. D. Wilson, livery for L. S. Smith in June -----	30 00
July	13.	J. R. Ellis, pay and subsistence roll for June -----	355 00
July	13.	R. W. Berry, pay and subsistence roll for June -----	735 00
July	13.	R. W. Berry, miscellaneous expenses in June -----	98 95
July	18.	L. S. Smith, field and miscellaneous expenses in June	90 96
July	18.	J. R. Ellis, per diem subsistence and miscellaneous expenses in June -----	186 00
July	18.	W. H. Williams & Son, livery for McNair in June ----	40 50
July	18.	Cambron & Clements, livery for Berry party in June --	73 50
July	18.	W. J. Greenwell, board of W. J. Lloyd in June -----	45 00
July	18.	W. M. Payne, livery for Berry party in June -----	39 75
July	18.	A. L. Grady, livery for Berry party in June -----	22 75
July	18.	Ashby Bros., livery for Berry party in June -----	43 50
July	18.	J. C. D. Hapgood, livery for Berry party in June -----	31 00
July	18.	W. J. Greenwell & Co., board of R. W. Berry in June	36 00
July	18.	W. J. Waller, pay as rodman, 4 days in June -----	4 00
July	18.	Cambron & Clements, livery for W. J. Lloyd in June --	34 50
July	18.	J. J. Watkins, livery for Berry party in June -----	13 50
July	18.	E. L. McNair, per diem subsistence and miscellaneous expenses in June -----	166 16
Aug.	6.	R. W. Berry, pay and subsistence roll for July -----	648 00
Aug.	14.	J. H. Clinton, subsistence of R. W. Berry, (5 days) and L. B. Pride (3 1-4 days) in July -----	12 37
Aug.	14.	D. Y. Combs, feed for horses used by E. L. McNair and party, 26 feeds in July -----	13 00
Aug.	14.	J. R. Sowders, livery for R. W. Berry and E. E. Barton in July -----	24 00
Aug.	14.	A. L. Grady, livery for R. W. Berry, and E. L. Keenan, in July -----	42 00
Aug.	14.	W. M. Payne, livery for R. W. Berry and party in July	55 50
Aug.	14.	Fowler Stafford, livery for W. H. Sallee Sidney Jenkins, F. H. West and J. O. Sallee in July -----	76 12
Aug.	14.	Scott & Scott, livery for L. S. Smith and party in July	137 00
Aug.	14.	E. L. McNair, pay and subsistence roll for July -----	94 25
Aug.	14.	L. B. Pride, 6 days in July as rodman in R. W. Berry's party -----	6 00
Aug.	14.	W. N. Morrill, pay and subsistence roll for July -----	419 50
Sept.	3.	W. P. Dudley, pay and subsistence per diem, (E. L. McNair party) for August -----	\$ 84 25
Sept.	3.	G. K. Chapman, pay and subsistence per diem (L. S. Smith party) for August -----	96 50
Sept.	3.	R. W. Berry, pay and subsistence per diem roll for August -----	468 67

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Sept.	8.	E. L. McNair, subsistence per diem and miscellaneous expenses for August -----	\$153 80
Sept.	8.	W. N. Morrill, pay and subsistence per diem roll for August -----	514 00
Sept.	8.	L. S. Smith, pay and subsistence per diem roll for July -----	102 00
Sept.	8.	G. W. Moscow, livery for G. K. Chapman, (L. S. Smith party), 12 days in August -----	18 00
Sept.	8.	Scott & Scott, livery for L. S. Smith (4 days) and G. K. Chapman, (15 days) in August -----	58 00
Sept.	8.	W. D. Wallingford, livery for R. P. Thompson, 3 2-3 days in August -----	5 50
Sept.	8.	Tom Williamson, livery and driver for E. L. McNair, 31 days of August -----	117 80
Sept.	15.	W. H. Sallee, expenses July 2 to August 31 -----	25 05
Sept.	15.	I. Sidney Jenkins, expenses July 6 to August 31 -----	13 22
Sept.	15.	W. N. Morrill, subsistence per diem and miscellaneous expenses, 21 days in August -----	71 33
Sept.	15.	W. M. Payne, livery for R. W. Berry and party in August -----	85 00
Sept.	15.	J. J. Watkins, livery for E. E. Barton (Berry party) 4 days in July -----	6 00
Sept.	15.	A. O. Burkland, subsistence per diem and miscellaneous expenses in August -----	89 98
Sept.	15.	J. O. Sallee, miscellaneous expenses July 19 to August 29 -----	20 36
Sept.	15.	A. L. Grady, livery for R. W. Berry and party in Aug.	68 25
Sept.	15.	Fowler Stafford, livery for W. H. Sallee, Sidney Jenkins & J. O. Sallee (W. N. Morrill party) in August	107 75
Sept.	15.	S. Ragan & Son, livery for W. N. Morrill and A. O. Burkland in August -----	55 25
Oct.	2.	R. W. Berry, pay and subsistence per diem roll for September -----	106 67
Oct.	2.	G. K. Chapman, (L. S. Smith party) pay & subsistence per diem; 4 days in Sept. -----	12 67
Oct.	2.	A. L. Grady, livery for R. W. Berry & Party in Sept. --	39 00
Oct.	2.	L. H. N. Salyer, livery for E. L. McNair and W. P. Grady, in September -----	17 25
Oct.	2.	R. W. Berry, subsistence per diem and miscellaneous expenses in September -----	93 80
Oct.	9.	W. N. Morrill, pay & subsistence roll (Sallee & others) for September -----	162 30
Oct.	9.	E. L. McNair, (Dudley, field assistant) pay & subsistence roll for September -----	82 50
Oct.	9.	Amos L. Lindsay, pay as "laborer" for W. H. Monahan, 12 days in September -----	30 00

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Oct. 9.	W. H. Monahan, Field Assistant, (Levels from Lexington to Jackson), 20 days in Sept.-----	\$159 60
Oct. 9.	L. S. Smith, Top Aid, traveling & per diem expenses in September-----	93 10
Oct. 9.	Tom Williamson, livery & driver for E. L. McNair, 28 days in September-----	106 40
Oct. 9.	Scott & Scott, livery for L. S. Smith, 18 days in Sept.---	36 00
Oct. 30.	L. S. Smith, pay and per diem roll (for F. P. Hoover & O. B. Howard), for August-----	62 33
Nov. 10.	A. L. Lindsay, (with W. H. Monahan), pay, 2 days in Oct.-----	5 00
Nov. 10.	W. N. Morrill, subsistence per diem & miscellaneous expenses in October-----	105 91
June 11.	C. B. Kendall, traveling expenses, May 27, 28, 29----	25 20
July 31.	C. B. Kendall, pay & subsistence roll, (C. W. Renshaw & others), for July-----	168 33
July 31.	T. H. Stone, hire of team, 2 horses & three seated hack, for C. B. Kendall, Field Ass't., for use in transporting primary traverse party to and from work in vicinity of Hartford, Ky., July 1 to 10, inclusive--	30 00
Aug. 17.	A. O. Burkland, pay & subsistence roll, (R. E. Johnson & 3 others), for July-----	396 00
Aug. 17.	A. O. Burkland, pay & subsistence roll, (Spencer Smith & 7 others), for July-----	752 50
Aug. 17.	L. B. McCarty, livery for field work on the Whitesville, Ky. sheet, under direction of C. C. Gardner, Jr. Topogr., (Gardner & party), in July-----	130 50
	and, hire of single horse & buggy for F. H. Moncure, Topog. Aid, for work on Whitesville, Ky. sheet, 10 days in July-----	20 00
Aug. 17.	W. T. Hamell, livery for S. C. Smith, traversemen, July 25 to 31, inclusive, & for W. H. Sallee, traverseman, July 25 to 31, inclusive & ½ day on 24th----	15 75
Aug. 17.	T. M. Baker, livery for A. O. Burkland, R. E. Johnson, W. H. Sallee, & G. W. Crane, in July-----	70 75
Aug. 17.	W. J. Barnhill, livery for A. O. Burkland, J. A. Lilly, R. E. Johnson, W. H. Sallee, & G. L. Hayman, in July-----	63 00
Aug. 17.	A. O. Burkland, traveling & miscellaneous expenses for expenses for self & party, in July-----	28 09
Aug. 17.	O. A. Burkland, traveling & miscellaneous expenses for self & party, in July-----	17 62
Aug. 17.	A. O. Burkland, traveling & miscellaneous expenses for self & party, \$69.75, and subsistence per diem, \$19.14, in July-----	88 89

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Aug. 17.	W. A. Smith, livery for A. O. Burkland, R. E. Johnson, J. A. Lilly, in July-----	\$14 00
Aug. 22.	T. H. Moncure, miscellaneous field expenses in July----	21 55
Sept. 3.	W. A. Smith, livery for A. O. Burkland and party in July-----	118 00
Sept. 3.	W. T. Howell, livery for S. C. Smith and W. H. Sallee, in July-----	39 00
Sept. 17.	A. O. Burkland, pay & subsistence roll, (W. H. Sallee & Spencer Smith), for Aug.-----	218 00
Sept. 17.	A. O. Burkland, pay & subsistence roll, (R. E. Johnson and 7 others), for August-----	757 50
Sept. 17.	T. H. Moncure, pay & subsistence roll, (B. B. Barton & 2 others), for August-----	175 50
Sept. 17.	C. E. Barnett, livery for R. L. Harrison, Topog. Aid, 11 days in August-----	19 25
Sept. 17.	C. C. Gardner, Jr. Topog., miscellaneous expenses, August 12 to August 22-----	4 00
Sept. 17.	L. B. McCarty, livery for C. C. Gardner, Jr. Topog. for field work on Whitesville, Ky., quadrangle, single horse & buggy, in August-----	41 00
Sept. 17.	A. O. Burkland, Ass't. Topog., expenses and subsistence per diem for self & party in Aug.-----	167 27
Sept. 17.	W. T. Howell, livery for W. H. Sallee and S. C. Smith, in August-----	40 50
Sept. 17.	L. B. McCarty, livery for T. H. Moncure, in Aug. and B. B. Barton, 1 day & part of 1 day, in Aug.---	57 00
Sept. 17.	T. H. Moncure, traveling & miscellaneous expenses, in August-----	28 58
Sept. 17.	W. A. Smith, livery for A. O. Burkland, R. E. Johnson & G. L. Hayman, in August-----	41 75
Sept. 17.	Robt. Crow, livery for J. A. Lilly, G. W. Crane & R. L. Harrison, in August-----	43 75
Oct. 12.	H. B. Spencer, livery for A. O. Burkland and R. E. Johnson, in September-----	47 25
Oct. 12.	A. O. Burkland, pay & subsistence roll, (W. H. Sallee & 12 others), for August-----	1,099 46
Oct. 12.	Barnett & Crow, livery for A. O. Burkland and 5 others, in September-----	127 50
Oct. 12.	L. B. McCarty, livery for T. H. Moncure, in September-----	46 50
Oct. 12.	T. H. Moncure, traveling & miscellaneous expenses, for September-----	11 59
Oct. 12.	C. C. Gardner, traveling & miscellaneous expenses, for September-----	17 29
Oct. 12.	R. L. Harrison, miscellaneous expenses and subsistence per diem for Sept.-----	68 55

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Oct. 12.	L. B. McCarty, livery for C. C. Gardner & B. B. Barton, for work on Whitesville quadrangle, for September -----	\$43 25
Oct. 18.	Oscar Stevens, livery for R. E. Johnson, J. A. Lilly & G. W. Crane, in September -----	54 25
Oct. 18.	A. O. Burkland, traveling expenses and subsistence per diem for September -----	203 00
Oct. 21.	Barnett & Crow, livery for R. L. Harrison, (3½ days), & for G. L. Hayman, (1 day), in Oct. -----	10 12
Oct. 21.	W. T. Howell, livery for B. B. Barton, 15 days, and for Spencer Smith, 26 days, in Sept. -----	61 50
Nov. 9.	R. L. Harrison, traveling & miscellaneous expenses, for October -----	22 91
Nov. 9.	R. L. Harrison, subsistence per diem, for Oct. -----	62 00
Nov. 9.	L. B. McCarty, livery for T. H. Moncure, 27 days in October -----	54 00
Nov. 9.	L. B. McCarty, livery for C. C. Gardner, (work on Whitesville quadrangle), 28½ days in Oct. -----	57 25
Nov. 9.	S. D. Groves, livery for J. M. Dyer, levelman, Sept. 23. to Oct. 24, inclusive -----	26 66
Nov. 9.	O. B. James, (Centertown), livery for A. O. Burkland, 13 days in October -----	19 50
Nov. 9.	A. O. Burkland, pay & subsistence roll, (R. E. Johnson & 14 others), for October -----	1,100 71
Nov. 15.	T. H. Moncure, traveling & miscellaneous field expenses in October -----	20 21
Nov. 15.	C. C. Gardner, Jr. Topog., traveling and miscellaneous field expenses in October -----	9 10
Nov. 15.	Oscar Stevens (Beaver Dam), livery for R. W. Berry, R. E. Johnson, J. A. Lilly, & transportation for H. W. Peabody and rodman, in October -----	56 00
Nov. 15.	A. O. Burkland, subsistence per diem and traveling expenses, in October -----	228 17
Dec. 6.	L. B. McCarty, (Whitesville), hire of single horse & buggy, T. H. Moncure, 7 days in Nov. -----	14 00
Dec. 6.	Ross L. Bennett (Rockport), to feed & care of one public animal, 28 feeds, \$7; to feed & care of one Survey animal, 10 feeds, \$2 50, and hire of one horse for Survey use, 1 day, Nov. 7, \$1 25 -----	10 75
Dec. 6.	Oscar Stevens, (Beaver Dam), livery for R. W. Berry, 13 days, R. E. Johnson, 14 days & A. O. Burkland, 8 days, in November -----	61 25
Dec. 6.	A. O. Burkland, pay & subsistence roll, (R. E. Johnson & 10 others), for November -----	562 34

Total, December 6, 1905, to December 6, 1907 ----- \$17,421 70